IMPERIAL BUREAU OF MYCOLOGY

REVIEW

OF

APPLIED MYCOLOGY

VOL. II SEPTEMBER 1923

COTTON (A. D.). **Potato pink rot: a disease new to England.**—*Journ. Min. Agric.*, xxviii, 12, pp. 1126-1130, 1922.

During the summer of 1921 cases of potato pink rot (*Phytophthora erythroseptica*) were discovered in Shropshire and Hertfordshire. This is the first record of the disease in England, and although it is not necessarily true that it is new to the country, it is certainly as yet not present to any serious extent. As its symptoms in the growing plant are those of a wilt, while the denuded stems somewhat resemble those which have been severely attacked by *Phytophthora infestans*, it has possibly been mistaken for these diseases. In Shropshire pink rot was found in six localities near together, the variety attacked in all cases being Great Scot, grown from Scotch seed; this fact would point to the introduction of the disease with the seed from Scotland, where it is known to occur. In Hertfordshire the outbreak occurred in only one isolated field which had not been under potatoes for five years. The seed was home-saved, and the crop during 1920 showed no signs of pink rot. The indications are that the disease in this case was introduced with 'London manure' with which the field had been heavily dressed, and which contained a large amount of vegetable débris, including market refuse. A brief description is given of the disease, which owes its popular name to the fact that cut surfaces of infected tubers rapidly turn pink when exposed to the air. In some of the western districts of Ireland it has caused considerable losses, exceeding at times those due to *P. infestans*. It has been known there for years, but apparently has not spread to any extent. With proper rotation of crops, care in the use of healthy seed tubers, and precautions in regard to town manure highly contaminated with vegetable refuse, there is no reason to fear further serious outbreaks in England. Where pink rot has occurred, diseased haulms and tubers should on no account be left lying about and especially not allowed to reach the manure heap. Spraying is useless against this disease.

DOIDGE (ETHEL M.). **Potato diseases.**—*Journ. Dept. Agric. S. Africa*, vi, 1, pp. 71–78, 1923.

In this paper an illustrated list of South African potato diseases is given, with brief popular descriptions and recommendations as to suitable methods of control.

WHETZEL (H. H.). **The Alternaria blight of Potatoes in Bermuda.** *Phytopath.*, xiii, 2, pp. 100–103, 1 fig., 1923.

The author describes an epidemic of early blight (*Alternaria solani*) of potatoes which occurred in Bermuda in the early winter of 1921. The disease appeared about mid-November on a luxuriant crop, and by the end of the month one-third of the potato fields were severely affected; the best yields from blighted fields were six barrels to one of seed planted. Features peculiarly striking in this outbreak were (*a*) its suddenness, (*b*) its severity, (*c*) the size of the leaf lesions and their similarity to those of late blight (*Phytophthora infestans*), and (*d*) the development of large water-soaked lesions on the stalks.

BISBY (G. R.), HIGHAM (J. F.), & GROH (H.). **Potato seed treatment in Manitoba.**—*Scient. Agric.*, iii, 6, pp. 219–221, 1923.

Soil infestation with the fungus that causes black scurf of potatoes (*Rhizoctonia solani*) in Manitoba is such as to render the tubers extremely liable to attack, and the results of three years' experiments have shown that the disease cannot be controlled by the ordinary methods of seed treatment (corrosive sublimate, formaldehyde, and copper sulphate), found efficacious in other areas, where infection appears to result more commonly from the fungus on the surface of the seed.

During 1922, tests were made of the effect of planting and harvesting tubers at different dates, on the incidence of black scurf. Potatoes dug on 1st September showed an average of 39 per cent. affected by the disease; those dug on 10th September, 43·3 per cent.; on 4th October, 71·4 per cent.; and on 13th October, 82·8 per cent. Thus the longer the tubers were left in the ground, the higher was the percentage of infection. The average percentage of black scurf on potatoes planted on 5th May and dug at different dates was 73; those planted on 15th May gave 80; 22nd to 26th May, 76; 29th May to 1st June, 81; 10th June, 61·2; 20th June, 39·2; and 1st July, 42·5. Late planting within the time limits that are practicable in Manitoba, was therefore not effective in the prevention of the disease.

GOSS (R. W.). **Potato diseases in Nebraska.**—*Nebraska Agric. Exper. Stat. Bull.* 186, 32 pp., 12 figs., 1923.

The following potato diseases occur in Nebraska: *Rhizoctonia* (*Corticium vagum*), *Fusarium* wilt and stem-end rot (*F. oxysporum* and *F. eumartii*), blackleg (*Bacillus phytophthorus*) [*B. atrosepticus*], scab (*Actinomyces scabies*), dry rot (*Fusarium tricothecioides*), early blight (*Alternaria solani*), mosaic and curly dwarf, leaf roll, net necrosis, hopperburn, tipburn, black heart, hollow heart, internal brown spot, and frost necrosis. In addition

to a short account of each disease there is a table showing the symptoms, methods of transmission, and control measures.

Diseases carried on the surface of the tuber, such as scab and *Rhizoctonia*, may be controlled by seed treatment with corrosive sublimate (4 oz. to 30 galls. water). Owing to the absence of late blight [*Phytophthora infestans*] in Nebraska it is doubtful whether any advantage is to be derived from spraying.

TRINCHIERI (G.). **Su la pretesa presenza, in Italia, della 'rogna nera' della Patata.** [On the alleged occurrence of the black wart disease of Potato in Italy.]—*Riv. di Biol.*, v, 1, pp. 139–140, 1923.

Commenting on Dickson's paper 'Diseases of the Potato' [see this *Review*, ii, p. 26], the author refutes the statement that wart disease of potato [*Synchytrium endobioticum*] occurs in Italy, basing himself on the results of inquiries made up to date by the Italian Phytopathological Service. Furthermore, an order issued by the Ministry of Agriculture in 1921, and still in force, prohibits the importation into Italy of potatoes and of fruits and plants of all other Solanaceae from abroad with a view to protecting the potato crops against the introduction of the disease.

SCHULTZ (E. S.) & FOLSOM (D.). **A 'spindling-tuber disease' of Irish Potatoes.**—*Science*, N.S., lvii, p. 149, 1923.

Recent investigations by the authors have shown that a potato malady commonly known as 'running long' is an infectious disease, transmissible from affected to healthy plants by means of tuber and haulm grafts, leaf-mutilation inoculation, and plant lice. The disease is perpetuated from year to year by the tubers, and in the absence of control measures the incidence of infection in a given stock increases annually.

Plants infected late in the season may show no symptoms of the disease, while those infected early have erect, spindling stalks, smaller, more upright, and darker leaves than the normal foliage, and more cylindrical, spindling, and spindle-shaped tubers than healthy or apparently healthy plants. The eyes of the tubers are numerous and more conspicuous than usual. The yield is somewhat reduced in the first year, and there is a progressive decrease in later years in production from plants grown from spindling tubers. The term 'spindling-tuber disease' is proposed as appropriate to the symptoms described.

Further data on this and other so-called 'degeneration' diseases of the potato will be published in a later paper.

EDSON (H. A.) & SHAPOVALOV (M.). **Parasitism of Sclerotium rolfsii on Irish Potatoes.**—*Journ. Agric. Res.*, xxiii, 1, pp. 41–46, 3 pl., 1923.

Both the haulm and tuber of the Irish potato may be attacked by *Sclerotium rolfsii*, the symptoms of the disease varying with the age and environmental conditions of the plant. Very young plants growing in extremely damp soil are most likely to show signs of damping-off, while older plants may suffer from a rot of the roots

or stems, or both, with subsequent wilting of the leaves and stems, the latter eventually lying prostrate on the ground.

Natural infection in the field was observed in an advanced stage in several southern States, the symptoms produced generally resembling those of wilt or stem blight. The stems were decayed at or near the surface of the soil, and in some cases the rotting of the underground tissues was so severe that only a few strands of vascular fibre remained attached if the tops were lifted. Wefts of mycelium or the sclerotia of the fungus would be seen clinging to the stem or extending radially from the plant in and on the surface of the soil.

Inoculation experiments carried out in 1919 at Arlington, Virginia, on forty tubers of the Irish Cobbler and Bliss Triumph varieties, with two different isolations of the fungus (*Sclerotium* nos. 126 and 127), resulted in severe infection. In 1920 the tests were repeated on the Irish Cobbler variety only, with two sets of plantings. In both tests the successive development of the various symptoms of the disease was essentially the same. There were first some missing hills where the seed pieces were destroyed in the ground, then some of the young plants that had come up showed symptoms of damping-off, and finally wilt, stem rot, and blight followed in the older plants. In 1919 no tubers were found in any of the thirty-five hills destroyed by the fungus, while the remaining five hills produced very small ones. The yield of the control plants was satisfactory. The severity of the attack of the two isolations differed somewhat, *Sclerotium* no. 126 (from North Carolina) destroying all the inoculated plants, while *S.* no. 127 (from Arkansas) appeared to be less virulent, five of the inoculated plants, though undersized, remaining otherwise unaffected by the disease. There was no perceptible difference in the response of the two varieties used.

In 1920 the most serious infection with *S.* no. 126 took place in the later of the two plantings or late in the earlier planting, while with *S.* no. 127 the position was reversed. These results indicate that the Arkansas isolation was more adapted to cooler, and the North Carolina to warmer, temperatures. In this experiment the total number of infected hills with *S.* no. 126 was nineteen, and with *S.* no. 127 only eight, out of twenty-four inoculated in each case. The apparently weaker pathogenicity of the latter accords well with the results of the 1919 tests.

The markedly different parasitic action of the two *Sclerotium* isolations and their different behaviour in the field suggest the existence of distinct morphological strains in *S. rolfsii*. Taubenhaus's assertion that the fungus comprised neither varietal nor physiological strains (*Journ. Agric. Res.*, xviii, 3, pp. 127–138, 1919) can be accepted only in respect of the particular strains included in his studies, and not of the species as a whole. The sclerotia of strain no. 126, considered relatively, were always larger than those of no. 127, and also showed a tendency to mass in clusters.

Potato tubers naturally or artificially infected with *S. rolfsii* are subject to a rapid progressive decay, the affected tissues being practically odourless and colourless in the earlier stages, but assuming a yellowish tinge in the older portions; they are also usually more

or less porous. Strain no. 126 was isolated from this type of 'white rot', which may, under favourable conditions of humidity and temperature, develop into the so-called 'melter' type, in which the affected portions become very soft and watery. Both relatively young sclerotia and young mycelium of the fungus were used with equal success in the inoculation experiments, the inoculated tubers being placed in glass moist chambers or stone jars at a temperature of 20° to 22° C. for a fortnight.

The destructive effect of the fungus on tuber tissue was clearly seen on sterile raw potato blocks inoculated in Erlenmeyer flasks. The blocks were rapidly enveloped by a dense growth of pseudo-parenchymatous mycelium, followed by abundant sclerotial formation in large, compact aggregates which were often an inch or more in diameter. At the maximum of mycelial development an increasing accumulation of light amber liquid appeared in the bottom of the flasks. This liquid obviously resulted from the action of the fungus on the potato. The mycelium did not penetrate the blocks, and it is therefore logical to infer that digestive enzymes are secreted which dissolve the host tissue, the latter being rendered available to the fungus by means of diffusion and osmosis. The middle lamellae are first softened, then the cell contents and cellulose walls, the starch being evidently the last of the solids to disappear. Partial autolysis of the mycelium and sclerotia occurred when the cultures were left undisturbed for a sufficient period.

Disks of raw potato in water treated with enzyme preparations of the hyphae softened to a curd-like consistency. Disintegration took place through the softening of the middle lamellae and consequent liberation of the individual cells, the process corresponding exactly with that described above as the initial stage of decomposition by the fungus itself.

SHAPOVALOV (M.). **Relation of Potato skinspot to powdery scab.**—*Journ. Agric. Res.*, xxiii, 4, pp. 285–294, 4 pl., 1 fig., 1923.

The skin spot disease of the potato tuber has been attributed to various organisms, and recently by Miss Owen to *Oospora pustulans*, but the author regards all these alleged causes as unconvincing, and believes skin spot to be primarily a young stage of powdery scab (*Spongospora subterranea*), although various saprophytic fungi are frequently found in the diseased spots. He states that the geographical distribution of skin spot is markedly similar to that of *S. subterranea*, and that it has not yet been reported from those regions where the latter is unknown. *O. pustulans* is either rare or entirely absent in the skin spot material of the United States, and in spite of the continuous influx of skin spot infected tubers into that country fails to establish itself, this behaviour being exactly similar to that of powdery scab.

In arrangement and appearance there is a great similarity of skin spot pustules to the closed sorus condition of powdery scab. On some tubers all stages of *S. subterranea* can be seen, and it is difficult to determine whether the infections should be classed as skin spot or powdery scab.

The writer was not able to detect plasmodia of *Spongospora* in the skin spot pustules, and suggests that this may be due to its

disappearance at certain stages of development from spaces it formerly occupied. On the other hand, hyphae are entirely absent from a certain number of the pustules.

The formation of new cork below a skin spot, signifying the cessation of activity by the parasite, is inconsistent with the view that the damage is caused by *Oospora pustulans*, which is said to be invisible at lifting time, but to develop considerably in the stored potatoes as spring approaches. On the other hand, it is quite in harmony with the progress of powdery scab, which is active during the growing period of the tuber, but usually is more or less checked during storage.

Undoubted skin spot material was obtained from various parts of the world and yielded *O. pustulans* in 36·1 per cent. of cases. A number of plantings were sterile, and various other fungi were also obtained. *S. subterranea*, only once cultured by Kunkel, naturally did not occur. Inoculations of healthy tubers with *O. pustulans*, like those of Miss Owen, gave negative results, and the view is held that all the fungi isolated are mainly secondary invaders, developing during the storage period, whose presence is altogether unnecessary to give the appearance of skin spot. The principal invader in Pennsylvania is *Colletotrichum atramentarium*, in Germany a *Phoma*, in England *Oospora pustulans*.

If skin spot is merely an immature condition of powdery scab, then the abundance of the immature stage of the latter disease in certain years becomes an interesting phenomenon which may be due to various causes, e.g. an early check in the development of the disease, a late infection, drought, or varietal response.

CHARDON (C. E.) & VEVE (R. A.). **The transmission of Sugar-cane mosaic by Aphis maidis under field conditions in Porto Rico.** —*Phytopath.*, xiii, 1, pp. 24–29, 1 fig., 1923.

The authors have conducted a number of experiments in Fajardo, Porto Rico, the results of which tend to establish that the disease is transmitted by *Aphis maidis*. The discovery by Wolcott, at Santa Rita, of a quantity of *A. maidis* in the central whorl of leaves of young plants, correlated with a marked increase of mosaic disease, formed the starting-point of the investigations. In each of two large insect-proof cages, 24 by 15 by 5 feet, forty-eight setts of the susceptible DIIII cane variety were planted at ordinary field distances. In one case half the setts used were diseased, and the other half healthy. A large quantity of the common grass 'malojillo' (*Eriochloa subglabra*), a favourite host of *A. maidis*, was planted in cage A (which was not weeded), and a number of the insects introduced into it. Cage B was kept free from weeds and insects, and served as a control. One month after planting, when the cane plants were six to eight-inches in height, the weeds in cage A, which included, besides *E. subglabra*, *Cyperus rotundus*, *Echinochloa colona*, *Eleusine indica*, *Syntherisma sanguinalis*, *Portulacca oleracea*, *Chamaesyce hypericifolia*, *Commelina* sp., *Amarantus spinosus*, and *Ipomoea tiliacea*, were systematically removed. Early the next day (the weeding having taken place at 5 p.m.) the aphids were seen feeding on the central whorl of the young cane plants, where they stayed until their favourite hosts grew again. Of these

Eriochloa subglabra decidedly ranked in the first order of preference, followed by *Echinochloa*, *Eleusine*, and *Syntherisma*. Secondary infection of the sugar-cane appeared quickly after this, the first case in two weeks, and fifteen out of the twenty-four healthy plants (62·5 per cent.) were infected by the end of two months. The plants in the control cage remained quite healthy throughout. Three of the grasses in cage A, *Syntherisma sanguinalis*, *Eleusine indica*, and *Echinochloa colona*, exhibited true symptoms of mosaic, from which, however, the favourite aphid host, *Eriochloa subglabra*, appears to be immune.

The locality in which the experiments were carried out is remote from any possible source of infection, so that the new cases of mosaic in cage A must have come from the diseased plants in the cage, and it is suggested that the infection must have been transmitted by *A. maidis*, the only insect present.

WAKEFIELD (F. W.). **A biometric study of the conidia of Macrosporium and Alternaria.**—*Papers and Proc. Roy. Soc. Tasmania, 1922*, pp. 27–31, 1 graph, 1923.

The dimensions of fungus spores are subject to considerable variation, and a marked lack of uniformity frequently characterizes the descriptions of an identical fungus by different authorities. Previous investigations by the author having shown a considerable range of variation in the dimensions of the conidia produced by (*Cladosporium graminum* Cda. (*Scolecotrichum graminum* Fckl) and other species, a critical examination of two common species, *Macrosporium cladosporioides* Desm. and *Alternaria brassicae* var. *citri* Penz., was undertaken. These fungi have morphologically similar spores though they are borne in a different manner on the conidiophores. Cultures of the former were prepared on onion leaves, and were eight days old when the measurements were made. The *Alternaria* conidia were derived from a mandarin orange which was under observation on a culture dish. All the conidia measured in the latter series were taken from the same culture and the same centre of infection at approximately the same time.

The total number of measurements taken was 861, viz. 540 of *Macrosporium* and 321 of *Alternaria* conidia. The conidia of *M. cladosporioides* were found to vary in length from 17 to 51 μ, while the limit of variation observed in *A. brassicae* var. *citri* was 9 to 44 μ. In the former case the number of each length closely approximated to the curve of normal frequency, whereas in the latter the curve was considerably more complex, and probably represented a composite curve, consisting of a series of smaller, overlapping and intersecting curves. Each of the latter may possibly correspond to a conidium of fixed position with reference to the conidiophore, and in relation to the other conidia associated with it in the chain. A study of curves of the length-variation of detached free conidia would therefore indicate their solitary or concatenate origin, thus facilitating the correct classification of the morphologically identical conidia of *Macrosporium* and *Alternaria*.

GROVE (W. B.). **The British species of Cytospora.**—*Kew Bull. Misc. Inform.*, 1, pp. 1–29, 1923.

The author describes the characters of the genus *Cytospora* in

detail, and mentions those features which distinguish it from *Naemospora* and *Libertella*, two other tendril-forming genera with which it is apt to be confounded. There are notes on the best method of examining the fungus, the appearance of the spores as seen from different angles, the change of colour sometimes seen in the spore tendrils, and the type of evidence which field mycology can produce concerning related ascigerous stages. Sixty-two species are admitted for Great Britain, of which half have been referred to ascigerous forms, but the authorities for such relationships are not specifically stated. In a few cases notes of phytopathological interest are added. Localities in Great Britain and the world distribution are given, together with references to the systematic literature. The work closes with a host index of all the British species considered valid.

Report of the College of Agriculture and the Agricultural Experiment Station of the University of California, 1st July 1921 to 30th June 1922, 249 pp., 61 figs., 1922 [1923].

This report contains a brief record of the phytopathological work in progress at Berkeley, at the University Farm, Davis, and at Riverside. The following notes deal chiefly with some of the work not already noticed elsewhere.

Tests of cereal varieties, hybrids, and selections resistant to various diseases were continued by Mackie and his collaborators. Selections from Galgalos, Emmer x Defiance, and Algernon wheats have been obtained which have remained entirely free from bunt [*Tilletia tritici* and *T. levis*] for three successive years, though the seed grain was heavily inoculated with bunt spores each season. Of 998 varieties of wheat tested for resistance to *Puccinia graminis* and *P. triticina* under artificial epidemic conditions, forty-three were entirely free from the former and four from the latter, while others were very mildly attacked. *P. glumarum* was found to be able to infect a number of grasses belonging chiefly to the genera *Agropyron*, *Bromus*, *Elymus*, and *Sitanion*. Strains of barley resistant to scald (*Rhynchosporium secalis*) have maintained this character, the best yield combined with high resistance being given by Mariout C. 2775. Tests of the effect of sowing at different dates on this disease indicate that the attack on Coast or common barley is negligible for sowings after 20th January, and on common Mariout after 1st March.

Further work by Fawcett and Camp confirmed the identity of *Bacterium citrarefaciens* Lee, the cause of citrus blast, with the previously described *Bact. citriputeale* Smith, which causes black pit. The difference in the symptoms described in the two cases is due to differences in climatic conditions in the north of the State, where blast was found, and in the south, where black pit is prevalent. In the latter region symptoms resembling blast have now been found at high elevations and in moist, cloudy weather. Injury to the wing of the petiole is responsible for much of the infection. The organism can also attack *Quercus wislezenii*. Bartholomew has found that the black discoloration and ultimate breakdown of lemons, especially those suffering from internal decline [see below, p. 406], in storage or transit, is not caused by the spread

of internal decline through the tissues, but is due to infection by a species of *Alternaria*. Considerable losses have occurred in certain sections from this trouble, and control measures are under investigation. Shell bark of lemon trees has been investigated by Fawcett, whose cultural and inoculation experiments indicate that a fungus may be involved in the development of this disease.

Investigations of a disease occurring on the black walnut (*Juglans californica*) in two walnut-growing sections, have been conducted by Barrett and Batchelor. Both crown and roots may be attacked, and it is believed that a specific organism is concerned in the injury. Excessive moisture is probably a predisposing factor in the occurrence of the disease.

The results of further experiments by Fawcett on the prevention of brown rot due to *Pythiacystis citrophthora* showed that this decay was prevented on heavily infected fruit by washing with water at 115° F. for one minute or longer, and at 120° or 125° F. for half a minute or more. The development of brown rot on heavily infected fruit stored at 60° F. was prevented by treating with water at 115° F. for two minutes at any time within eight hours from the time of infection, and at 120° for two minutes at any time within thirty hours. The standard copper sulphate treatment of 1 in 1,000 was of little value after the lapse of four hours, and of none after eight hours.

The results of preliminary tests by E. H. Smith indicate that gradual infection by strains of *Pythiacystis* may take place at the crown of the roots of stone fruit trees seven or eight years old, provided the fungus comes into contact with a cut or bruise on the bark, even under normal soil and moisture conditions. The most vigorous tree inoculated showed the most infection, viz. an advance of $\frac{1}{2}$ to $\frac{3}{4}$ inch from the inoculation between January and May.

The same worker reported a disease similar to the eastern rough bark of apples, caused by *Phomopsis mali*, on slow-growing, mature pear trees near the coast. The *Phomopsis* isolated from the cankers strongly resembles the eastern organism, and appears to be identical with that previously reported as causing a die-back of young pomaceous trees in the same districts.

During the spring of 1922, bacterial gummosis of stone fruits, caused by *Bacterium cerasi* Griffin, occurred with unprecedented severity, climatic conditions having been exceptionally favourable for infection. According to Barrett, Bordeaux mixture gave promising results in the control of the disease in the Hemet district. The results of scarification experiments carried out by Tufts and Day, in March and April, with a view to arresting the cankers formed by this organism, were very satisfactory, the development of all the cankers being checked. This procedure consists of cutting off a thin slice of the outer bark and applying a disinfectant to destroy the bacteria in the affected area thus exposed. Several disinfectants were tried and the concentrations determined which would not destroy the cambium below the scarified bark. One part formalin solution (37·3 per cent.) to five parts 50 per cent. wood alcohol controlled the disease on apricots and almonds, but this concentration killed the cambium of cherry and plum trees. One part of formalin to ten of water would probably be safe for

the latter species. The work has not progressed far enough to prove that the bacteria were totally destroyed, but it is highly probably that the scarified cankers are cured. Similar tests with the fireblight (*Bacillus amylovorus*) canker on pears gave promising results. Observations extending from 1919 to 1922 on some forty varieties of apricots have shown that the Russian varieties, Black and Catherine, are entirely free from attack by *B. cerasi*, while the following are resistant: Large Early Montgamet, Early May, Rualt, Apricot Hybrid, Nicholas, and Alexander.

C. O. Smith continued his studies on the resistance to crown gall [*Bacterium tumefaciens*] of various species of *Prunus*. A high degree of resistance has been exhibited by the Japanese apricot, *P. mume*, which withstood a number of artificial inoculation tests. Six species of pear stocks (*Pyrus calleryana*, *P. betulaefolia*, *P.* 'ba Li', *P. serrulata*, *P. serotina*, and *P. ussuriensis*) planted in close proximity to stumps of trees killed by *Armillaria mellea* were found to be in a healthy condition after two years.

FREEMAN (W. G.). **Administration Report of the Director of Agriculture for the year 1921.**—*Dept. of Agric. Trinidad and Tobago*, 12 pp., 1922.

The following references to the diseases of economic crops are of interest. A special campaign was waged against the mosaic disease of sugar-cane, over 2,000 acres in the northern district of Trinidad being regularly inspected. The average infection at the beginning of the inspection course was 106 stools per acre, while at the close of the season it had been reduced to less than two. These encouraging results justify the hope that, with the continued co-operation of the planters, the disease may shortly be entirely eradicated.

Anthracnose (withertip or blossom blight) of limes [*Colletotrichum gloeosporioides*], first reported in 1918, is extremely widespread in Trinidad, occurring even on an isolated old tree at an elevation of over 800 ft. on the island of Chacachacare. In Tobago it appears to be present only on one estate where the limes were destroyed. By Regulations of 27th October [1921] the removal of lime plants, or parts thereof, from the infected area was prohibited. The Rangpur lime, stated to be resistant to anthracnose, has been introduced into Tobago.

Bud rot of coco-nuts was also prevalent.

BEVAN (W.). **Annual Report of the Director of Agriculture, Cyprus, for the year 1921,** 11 pp., 1922.

The only references of phytopathological interest in this Report are to the damage caused by *Peronospora* [*Plasmopara*] *viticola* in the Paphos and Limassol vineyards and the losses from *Oidium tuckeri* [*Uncinula necator*] consequent upon neglect of spraying. Active measures for the control of *P. viticola* were undertaken by the Department of Agriculture under an Order in Council, but weather conditions interfered with the operations at a critical period and it was also difficult to ensure the co-operation of the vine growers. The matter is receiving attention and further measures will be taken to control the disease.

EASTHAM (J. W.). **Report of Provincial Plant Pathologist, Vancouver.**—*Sixteenth Ann. Rept. Dept. of Agric. British Columbia for the year 1921*, pp. 64–69, 1922.

Amongst the new diseases noted during 1921, the wilt or *Sclerotinia* disease of clover (*S. trifoliorum*) caused severe injury to red clover in the Kootenay District. There is no evidence as to how the fungus was introduced, but its presence in British Columbia is decidedly serious, as it can attack a number of leguminous forage plants, including lucerne. Sweet clover [*Melilotus*], which is resistant to, if not immune from wilt, should be substituted for the susceptible varieties whenever possible.

Buck-eye rot of tomatoes (*Phytophthora terrestris*) caused some damage to the lower fruits in a Victoria greenhouse. In picking it is almost impossible to detect the early stages of infection, with the result that affected tomatoes decay in transit.

White pine blister rust (*Cronartium ribicola*) [see this *Review*, ii, p. 253], first detected at North Vancouver on 10th September 1921, was subsequently found to be widely distributed in the coastal section of the province. A quarantine was immediately put into effect to prevent the movement of *Ribes* and five-leaved pines from the infected area into the eastern part of the province, which is presumably free from the disease. Most of the Dry Belt is included in the protected area.

Late blight of potatoes [*Phytophthora infestans*] was severe in eastern areas. The disease provisionally termed 'skin spot' in a previous report has now been identified as a form of powdery scab [*Spongospora subterranea*; see also this *Review*, ii, p. 389].

Fireblight [*Bacillus amylovorus*] was present in a severe form in parts of the Okanagan Valley, and heavy infection was also found near Cranbrook. The recent embargo placed by the Commonwealth of Australia on all trees or fruits of host plants of *B. amylovorus* from countries in which fireblight is known to occur is considered to be unnecessarily sweeping. Considerable fruit areas in British Columbia have never been invaded by fireblight, and it is believed that shipments of fruit from such districts might reasonably be admitted into Australia under guarantee.

PROWSE (V. McN.). **Report of the Acting Economic Botanist and Plant Pathologist.**—*Ann. Rept. Dept. of Agric. Western Australia for the year ended 30th June* 1922, p. 31, 1922.

The most important feature of phytopathological interest during the year was the appearance of a new citrus disease at Kalamunda, Western Australia. The trouble was at first believed to be due to the fungus *Phoma omnivora*, the cause of withertip, but the subsequent examination of a further consignment of material showed that another fungus accompanied the withertip organism, and produced somewhat different symptoms. The name 'twig scorch' is suggested for the new disease on account of the withered or scorched appearance of scattered twigs on the tree, which give the impression of being charred by fire. The spores of the fungus are larger than those of the withertip organism and were referred to the genus *Macrophoma*, the name *M. destruens* being provisionally proposed, but without diagnosis.

The excision of diseased branches one foot below the grey, dead section and the application of Bordeaux mixture are recommended.

EATON (B. J.). **Report of the Director of Agriculture, Federated Malay States and Straits Settlements, for the year 1921,** 14 pp., 1922.

The report contains the following references to subjects of phytopathological interest. The two principal diseases of rubber under investigation during the year were pink disease (*Corticium salmonicolor*) and mouldy rot (*Sphaeronema fimbriatum*), the latter being closely correlated with heavy rainfall and damp conditions. Systematic treatment with disinfectants for the control of mouldy rot is being carried out, but owing to the neglect of small holdings consequent upon the low price of rubber the disease has become very widespread. Patch canker (*Phytophthora* sp.), thread blight, brown root disease [see this *Review*, ii, p. 291], and *Sphaerostilbe repens* were also observed. *Fomes lignosus* was prevalent on certain Chinese estates, especially where tapioca or gambier was interplanted with the rubber. Dry rot (*Ustulina zonata*) was of fairly frequent occurrence and wet rot (*Fomes pseudoferreus*) caused a good deal of damage on two estates in Negri Sembilan.

Black stripe (*Phytophthora faberi*) occurred near Katjang and in the Temerloh and Jelebu districts, but the treatment of this disease has now become a matter of routine. In Pahang the infected areas have been greatly reduced owing to the cessation of tapping. Brown bast has also been kept in check by the adoption of more conservative methods of tapping. Experiments in heavy tapping conducted on the Castleton Estate have shown a correlation between such tapping and the incidence of the disease [see this *Review*, ii, p. 178] and have also indicated that certain trees, for some unknown reason, remain immune in spite of these methods of latex extraction.

A new species of *Helminthosporium* attacking branches of badly grown rubber trees has been observed and also a branch canker not yet investigated. Several fungi, including a species of *Mucor*, *Pestalozzia palmarum*, and *Diplodia* were isolated from leaves arising from buds on three year old bud-grafted stock. The use of stocks which have attained this age appears to result in a weakness of the bud which predisposes it to disease.

Investigations on the bud rot disease of coco-nuts were continued. The disease is not epidemic in Malaya and may be due to several causes, including previous attacks of beetles. A bleeding disease, apparently different from that occurring in Ceylon, was fairly prevalent. Several fungi were isolated and are under study. Premature nut-fall was also studied.

Young African oil palms suffered from an affection of the heart leaves which could not be assigned to any definite agency and its relation to the coco-nut bud rot is being investigated.

LEVINE (M.). **Studies on plant cancers. V. Leafy crown galls on Tobacco plants resulting from Bacterium tumefaciens inoculations.**—*Phytopath.*, xiii, 3, pp. 107–116, 2 pl., 1923.

The author distinguishes two types of leafy crown galls on the

tobacco plant produced by *Bacterium tumefaciens*. The first type results from the inoculation of the midrib of the leaf and of the internodes of the stem. The growth of the gall is at first normal, but after two to three weeks diminutive leafy shoots develop, the leaf structures first appearing as small, greenish-white protuberances. The leafy crown gall appears to arise by a secondary process of differentiation; just as the small embryonic cells of the normal crown gall later become differentiated into various mature tissues, so those of the leafy crown gall become leaves and often modified stems and roots. The leafy crown galls on the stems become much larger than those on the midribs and the embryonic leaves which appear on them more numerous and larger; otherwise they are much the same.

The second type of crown gall is caused by the inoculation of stems at the axillary buds and is termed axillary leafy crown gall. It may be distinguished as a comparatively elongated, branch-like, axillary growth, which is undoubtedly the result of an abnormal development of the axillary bud. These structures are never so well developed as in the axillary shoot arising from a decapitated stem but are dwarfed, fasciated, and abnormal in appearance. Sometimes, however, inoculations of the axillary buds do not produce leafy shoots but large globular galls and the development of the dormant buds may be partially inhibited.

Inoculations at axillary buds of decapitated plants result in malformed, branch-like growths, generally stunted and with small, pale green leaves. The added stimulus of the decapitation, therefore, does not increase the size of the axillary leafy crown gall.

JOHNSTON (T. H.). **Biological control of the Prickly Pear pest.**—*Scient. Australian*, xxviii, 2, pp. 24–26, 1923.

The governments of Australia, Queensland, and New South Wales have co-operated financially in a scheme of investigations for the control of the prickly pear [*Opuntia*] by means of its natural enemies, including insects, fungi, and bacteria. Eight distinct kinds of fungi known to cause disease in prickly pears either in North or South America were obtained by the chief laboratory of the Prickly Pear Board, near Brisbane, only one of which (*Gloeosporium lunatum*) has hitherto proved to be of any value. Under certain conditions, namely, combined heat and moisture such as a Queensland summer furnishes, this fungus may set up a serious decay in *Opuntia* joints. So far it has not attacked any of the other plants tested.

While in Florida, the writer discovered a bacterial disease, the causal organism of which has been isolated and proved capable of causing a very virulent disease among all the species of prickly pear naturalized in Queensland and New South Wales. Attempts are in progress to secure the transmission of the bacterial disease from joint to joint (an essential to effective control) by the agency of moth borers (*Melitara* sp.) and the *Mimorista* moth.

Judging from the laboratory results, it appears that a complex of organisms has now been established in Australia which may ultimately secure the complete control of the prickly pear menace.

NOBLE (R. J.). **Studies on Urocystis tritici Koern., the organism causing flag smut of Wheat.**—*Phytopath.*, xiii, 3, pp. 127–139, 1 pl., 2 figs., 1923.

Studies on smuts have often been hampered by the difficulty of securing a vigorous germination of the spores and the present investigations with *Urocystis tritici* were directed to determining the conditions necessary for this to take place.

After many fruitless trials, it was found that spores which had been presoaked in water for several days would germinate profusely after the addition of small quantities of the tissue of wheat seedlings.

The stimulation by the latter is greater when the spores have been presoaked for 3 or more days than when it is added simultaneously with them. Dry spores sown on wheat plant infusions failed to germinate. A table is given showing the germination after various periods of presoaking before the addition of wheat tissues, a period of 4 days giving 90 per cent. germination whilst 28 days gave only 2 per cent. All portions of young wheat seedlings or even the whole uninjured wheat seedling were equally powerful as stimulants. There was no difference between tissues from einkorn, emmer, and spelt types nor from wheat susceptible or resistant to flag smut, and whilst wheat plant tissue was the most effective, tissues of rye, barley, oats, flax, and various grasses also stimulated germination to some extent. Autoclaved infusions and the distillates from water extractions of wheat seedling tissue also gave satisfactory results, showing that the stimulatory substances are volatile. The temperature relationships of *U. tritici* were found to be largely influenced by the presoak treatment the spores had received. For instance, a presoak period of 5 days at 20° C. gave good germination, but an additional presoaking for 30 hours at 27·5° C. reduced the germination to a trace. In distilled water spores incubated at temperatures varying from 7° to 27° C. for 3 days germinated in the following order on the addition of wheat tissue:—first at 18° C., then at 20°, 12°, and 7°, none occurring at 27° C., but spores presoaked at 20° C. for 6 to 8 days even germinated at 29° C. (and in one case at 32° C.) In another test, spores presoaked 6 days at 20° C. germinated well at 5° (and in one case at 0°) and growth was greatest at 24° C. although there was little difference in percentage germination between 18° to 27° C. Spores which have not been presoaked germinate most quickly about 18° C. When kept above 24° C. for some time, they respond less readily.

With regard to oxygen, spores of *U. tritici* germinated almost as readily and practically to the same extent when totally submerged as when sown on the surface, on receiving a suitable stimulus after presoaking. The promycelia of the former tended to become abnormally elongated before producing sporidia.

In germinating, the promycelium normally reaches 20 to 30 by 5 μ before the protuberances (usually 2 to 4 in number) which finally develop into sporidia are formed at the tip. The sporidia are cylindrical in shape and about 30 by 5 μ in size. Various irregular germinations were observed consisting chiefly of fusions or elongations of the sporidia or promycelium into long, thin germ-tubes.

In discussing the results obtained, the author points out that soil may be heavily infected with spores of *U. tritici* and a clean crop sometimes grown, while under other conditions a relatively small amount of inoculum may cause a serious outbreak. This apparent capriciousness would appear to be due to the operation of various factors,—soil moisture, soil temperature, soil aeration, and the presence of a stimulatory substance—and probably these factors must operate in proper sequence to cause the development of flag smut epidemics.

THOMPSON (N. F.). **Kill the common Barberry with chemicals.**—*U.S. Dept. Agric. Circ.* 268, 4 pp., 3 figs., 1923.

Of the several chemicals tested for the eradication of barberry, the best results were obtained by the use of salt and of a solution of arsenite. The former, either crushed rock salt or ordinary ground salt, should be piled in a dry state on the soil at the centre of the barberry bush, where it usually remains for several months, slowly dissolving. Ten pounds of salt are generally sufficient to kill an average bush, i.e., with a crown not over 12 inches in diameter. Smaller bushes may not need so much, but no bush should receive less than five pounds. The dose should be proportionally increased for larger bushes. The bush may be treated at any time of the year and may either be cut down or left standing.

The commercial sodium arsenite solution tested contained the equivalent of 8 lbs. of white arsenic (As_2O_3) per gallon [American]. For use it was diluted with 40 to 50 volumes of water, two gallons of the dilute solution poured into the centre of the plant so as to wet the base of each stem usually killed an average bush as defined above, but less than 1½ gallons should not be used even for small bushes. The best time for applying sodium arsenite is between the 1st May and the 30th September and the bush should be left standing. The soil immediately round the bush becomes sterilized as a result of both treatments, but this effect is of shorter duration with sodium arsenite than with salt.

Womit soll man beizen? [Which are the best seed disinfectants?]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, iii, 3, p. 17, 1923.

For the control of bunt of wheat (*Tilletia levis*) [and *T. tritici*] the following fungicides are recommended by the German plant protection service. Weizenfusariol, obtainable from W. C. Fikentscher, Marktredwitz, Bavaria; germisan (Saccharinfabrik, Magdeburg); formaldehyde and fungolit (Holzverkohlungsindustrie A. G., Constance, Baden); uspulun (F. Bayer & Co., Leverkusen); kalimat (L. Meyer, Mainz); and Präparat 23—Halle (Phytopathological Experiment Station, Halle-an-der-Saale). Fungolit and the two last-named preparations have been tested during 1922 only.

Stripe disease of barley [*Helminthosporium gramineum*] can be controlled by germisan and uspulun, and loose smut of oats [*Ustilago avenae*] by formaldehyde, germisan, sublimoform (Fikentscher, Marktredwitz), fungolit, and kalimat.

Loose smut of wheat and barley [*Ustilago tritici* and *U. nuda*] can only be controlled by immersion of the seed for ten minutes in hot water (50° to 52° C.). Immediately after steeping, the seed must be rinsed in cold water or spread out to cool. The quantities required for steeping 10 cwt. of seed wheat are 200 litres, barley 300 l., and oats 400 l. The seed should not only be sprinkled with the liquid but immersed in it. Wheat must be thoroughly stirred so that the uninjured bunt balls may rise to the surface and be removed by scooping off. Granary floors and grain sacks should also be disinfected to prevent subsequent infection of the seed.

HECKE (L.). **Neue Erfahrungen über Mutterkornkultur.** [New experiments in the cultivation of ergot.]—*Wiener landw. Zeit.*, lxxiii, 1–2, p. 3, 1923.

The author continued during 1922 his experiments on the cultivation of ergot for medicinal purposes [see this *Review*, ii, p. 114]. The work of infection was simplified by the use of a Perolin spray, and the total yield of ergot in 1922 was 527 kg. from one hect. of summer rye, or almost twice as much as in 1921. The average number of sclerotia per ear was 4·5, as against 3 in 1921. The sclerotia were normally developed, smaller and more symmetrical than those previously obtained from the winter rye. The yield of ergot from crosses between *Secale montanum* and rye was 370 kg. per hect., without any artificial stimulus to blossoming or artificial infection.

On the whole, the cultivation of ergot, which is at present fetching increasingly high prices, appears to be well worth while.

SAMPSON (KATHLEEN). **Seed treatment for smut in cereals.**—*Bull. Welsh Plant Breeding Stat. Aberystwyth*, Ser. C., 3, pp. 46–54, 1923.

The author discusses briefly the well-known disadvantage of seed grain disinfection with copper sulphate and formalin, a treatment which often results in a serious reduction of germination when the treated seed is sown in dry soil or stored for some time before sowing. Recently Harrington [*Journ. Agric. Res.*, xxiii, 2, p. 79, 1923] has shown that the practice of presoaking with a view to lessening formalin injury may itself cause a reduction of germination under certain conditions. It is, therefore, evident that a dry method of seed disinfection would be of value, and experiments are described giving the results of trials with dry copper carbonate against bunt of wheat [*Tilletia tritici*] and covered smut of barley [*Ustilago hordei*].

The grain was mixed with smut spores, and treated with ½ oz. powdered copper carbonate per ¼ bushel of grain, then stored for three weeks before sowing. There was no injury to germination or yield and very satisfactory control of the two smuts was obtained. The cost was, however, considerable (sixpence per bushel against one halfpenny and one penny for formalin and copper sulphate respectively).

Comparative tests with copper sulphate (2½ lb. to 10 galls. water) and formalin (1 in 320) for the control of the above diseases as well as loose smut of oats [*Ustilago avenae*] showed a reduction in

germination and yield when the seed was kept for three weeks before sowing. Copper sulphate followed by dusting with finely powdered slaked lime was better than the others, but still reduced the yield by 9 per cent. with wheat and 3 per cent. with barley, as compared with no reduction after copper carbonate and 27 and 10 per cent. respectively after formalin. Oat smut was completely controlled by formalin, but the yield was reduced by 3 to 10 per cent.

SAMPSON (KATHLEEN) & DAVIES (D. W.). **Incidence of fungus diseases on Oat varieties in the seasons 1921–22.**—*Bull. Welsh Plant Breeding Stat. Aberystwyth*, Ser. C., 3, pp. 55–57, 1923.

The incidence of fungous diseases on different varieties of oats during the seasons of 1921 and 1922 is recorded. Crown rust (*Puccinia lolii*) was practically absent in the former year when the harvest was unusually early. In 1922 the varieties most severely attacked were Orkney *strigosa*, Potato, Victory, and Yielder, Black Tartar, and American Sixty Day being relatively free from the disease.

Black rust (*Puccinia graminis*) has not been recorded on oats in the Aberystwyth experimental plots since 1920.

Mildew (*Erysiphe graminis*) was abundant in July 1921 and 1922, no variety showing any marked degree of resistance.

Loose smut (*Ustilago avenae*) occurred on 31 different varieties during the period 1920–22. Among those most severely affected were Radnorshire Sprig, Ceirch du Bach, and Potato.

Covered smut (*U. levis*) was recorded in the trial grounds only on *Avena nuda* var. *chinensis*, *A. strigosa* subsp. *glabrescens*, and *A. strigosa* subsp. *orcadensis*. A preliminary inoculation experiment with *U. levis* on a number of varieties susceptible to *U. avenae* gave negative results. The range of varieties susceptible to *U. levis* in Britain is believed to be limited.

Stripe (*Helminthosporium avenae*) occurred on 41 varieties of spring sown oats in 1921, Record, Yellow Naesgaards, Leader, and Goldfinder being the most severely affected, while Algerian *sterilis* was immune. In 1922 the disease was unimportant.

Halo blight (believed to be identical with the American disease caused by *Bacterium coronafaciens*) was especially severe in 1921 on Fulghum, an autumn sown variety, a few well-known spring oats, however, also being affected. In 1922 the autumn varieties escaped, but the disease was very severe on Odal, Black Tartar, Orion, and other spring varieties.

ALLEN (RUTH F.). **A cytological study of infection of Baart and Kanred Wheats by Puccinia graminis tritici.**—*Journ. Agric. Res.*, xxiii, 3, pp. 131–151, 6 pl., 1923.

An investigation of the process of infection of Baart (susceptible), Kanred (very resistant), and Mindum (semi-resistant) wheat seedlings by three strains of stem rust (*Puccinia graminis tritici*) has been conducted at Berkeley, California.

From inoculations with uredospores on Baart, and to a limited extent on Mindum seedlings, it was found that the germ-tubes take

the nearest route to the stomata ; the protoplasm is massed toward the growing tips leaving the older parts almost empty. On reaching a stoma the end of the germ-tube swells out to form an appressorium in the stoma aperture, a cross wall cutting off the now empty germ-tube which soon disappears. Within 24 hours of inoculating, many appressoria may be produced.

From the appressorium a blade-like wedge is forced through the stomatal slit, and this swells up inside to form the substomatal vesicle into which the cell contents pass leaving the collapsed appressorium outside. One or more hyphae are given off from the vesicle, and when the tip of one of those meets a host cell, and growth is forcibly checked, a haustorium is usually initiated. The hypha swells up, its contents become concentrated near the tip, which becomes closely applied to the wall of the host cell, and soon after a septum cuts off the haustorium mother cell whose contents are very dense. When the fungus is ready to enter, a minute pore is formed which allows the osmotic membranes of host and parasite to come into contact. The osmotic pressure in the latter is probably higher than in the former, and the substance of the haustorium mother cell pushes through into the host cell whose protoplast is forced inwards. The young haustorium consists of a dense ball of deep staining, fungous cytoplasm and a narrow neck joining this ball to the parent cell. Later the haustorium expands. Frequently the cell below the haustorium mother cell gives off one or more side branches which continue growth.

On Kanred seedlings, the process is similar, but very few (about 10 per cent.) of the appressoria grow through the stomatal slit to form mycelium in the host, the stoma being slender and the aperture small. Another strain of rust (*P. graminis tritici* iii) to which Kanred is less resistant, gave on the whole a larger number of successful entries (about 20 per cent.). When entry has been observed, the fungus passes in at one end of the stomatal slit and swells up inside. Haustorium formation commences in normal fashion, but with the entrance of the fungus into the host cell abnormal changes begin. The haustorium mother cell may collapse and shrink away from the host and a small, red-staining spot on the host cell wall mark the attempted point of entry. The appearance of sections suggest that some substances diffuse out from the host cell, disorganizing the haustorium-producing cell, and sometimes plasmolysing the cell below it also. Changes in the host cell are equally marked, an increase of turgor being rapidly succeeded by collapse and death. Walls of host cells adjacent to this dead cell become markedly thickened and thereby probably prevent the diffusion of substances to and from the diseased cell. A fungus which has been checked in this way once may still retain enough vigour to grow and may make a number of attempts (up to 6) to produce a haustorium. In some cases the reaction between host and parasite is more sluggish than has been described and the fungus may succeed in producing a haustorium thereby gaining food to grow on to the next cell before the first invaded cell dies. This process may be repeated a number of times, resulting in a succession of dead host cells (up to 24) and an ever weakening advance of the fungus. When a haustorium is formed, at

first it usually possesses the normal cytoplasmic envelope formed from the host cytoplasm, but in the older haustoria this is usually lacking, possibly because some substance diffuses from the haustorium which either destroys or repels the cytoplasm of the host cell. In old material all traces of the mycelium disappear, except the initial hypha at the stoma, but just how this happens is not clear.

In discussing her results, the author points out that Kanred possesses three means of defence against rust: (1) stomata which exclude all but a few germ-tubes [see this *Review*, ii, p. 359], (2) heavy contact walls adjoining pathological cells, and (3) a true immunity. She finds little support for the 'starvation' theory of immunity, as although the fungus exhausts itself in unsuccessful attempts to enter into food relations with the host, yet the failure is due not so much to lack of food as to a specific reaction set up in the host which destroys the fungus. As long as no haustorium is initiated, host and parasite remain unharmed, but when they come into contact each appears to give out substances harmful to the other. These observations are in line with the view that immunity is due to the formation of specific toxins and antitoxins as in the case of animal diseases.

A bibliography of 30 titles is given.

HILTNER (E.). **Havrens gråflecksjuka och dess botande med mangan.** [The grey speck disease of Oats and its control with manganese.]—*Landtmannen*, vii, 9, pp. 133–135, 2 figs., 1923.

The results of laboratory experiments with various mineral nutrient solutions have shown that the grey speck disease of oats [see this *Review*, i, p. 417] is promoted by the presence of potassium chloride, potassium nitrate, and calcium nitrate (singly or in combination). The injurious effects of these minerals in water cultures are counteracted by the addition to the solution of magnesium phosphate or potassium phosphate (or both). When KH_2PO_4 and $Ca(NO_3)_2$ are both present in the solution, grey speck does not occur but the plants suffer severely from chlorosis. A series of field tests indicated that oats are particularly liable to attack on heavily limed peat soils and on calcareous soils with an abundance of humus. Grey speck does not occur on sandy or clay soils even after the application of lime. The influence of light and shade on the development of the disease was also studied. Plants growing in the shade were found to be much more severely attacked than those in sunny situations.

It was shown by further tests that the disease could be completely controlled by the application of manganese salts together with potassium nitrate. This combination also ensures a higher yield. By expediting maturity and thus curtailing the period of growth (the critical stage in grey speck disease) manganese salts reduce the chances of attack to a minimum.

SAVASTANO (L.). **Lavoro della Stazione durante il periodo 1915–20.** [Work of the Station during the period 1915–20.]—*Ann. R. Staz. Sper. di Agrumic. e Frutic. in Acireale*, vi, pp. 125–138, 1922.

Amongst the plant diseases studied at this Experiment Station

in Italy a root rot of sour fruit trees, which brings about their rapid decay, constitutes a serious menace to the Sicilian citrus industry. Locally known as 'cagna', the disease is due partly to pathogenic agents—not all of which are as yet fully determined—and may occur either sporadically or in an intensely epidemic form, varying from year to year in accordance with weather conditions. The following factors tend to aggravate the trouble: (1) defective aeration due to compact and water logged soils; (2) reduced powers of resistance of the bitter orange brought about by attempts to accelerate and improve its yield by forced cultural methods; (3) close planting, which prevents solar action on the soil and helps to maintain excessive humidity, thus favouring parasitic growth and upsetting the trees' economic balance; (4) excessive manuring at long intervals which has the same effect and lowers vitality; (5) excessive and badly regulated irrigation; (6) the practice of 'verdello' ['verdelli' are lemons forced to maturity before the ordinary crop by special methods of irrigation] carried to excess in the lemon groves.

While these causes can undoubtedly be successfully met by appropriate cultivation, the question arises whether, and to what extent, the bitter orange could be replaced with advantage by some other stock more resistant to root rot. As under favourable soil conditions the bitter orange has so far proved sufficiently resistant, and its cultivation has been profitable, the Station has in these cases been content for the present to recommend cultural remedies, which experience has shown to be effective in keeping the disease within very narrow bounds. Experiments with stocks other than bitter orange are being carried out, exotics, however, being excluded for fear of introducing diseases, such as citrus canker, still unknown in Italy.

SAVASTANO (L.). **Contributo allo studio del male dello scopaccio negli Agrumi.** [Contribution to the study of 'witches' broom' on Citrus trees.]—*Ann. R. Staz. Sper. di Agrumic. e Frutticol. in Acireale*, vi, pp. 119–124, 6 pl., 1922.

Witches' broom disease of citrus was observed by the author for the first time in 1914 on a few isolated trees in Palermo. Although its occurrence in this district can be traced back for at least fifty years, the trouble is so rarely met with that no serious attention has been paid to it. A similar deformation has been observed on forest and ornamental trees, amongst the latter being cypress and *Broussonetia papyrifera*. Whereas witches' brooms are comparatively frequent on forest trees, and develop at times with great intensity, cultivated fruit trees are rarely attacked, and it is thought that this immunity may be due to pruning. On the other hand, in forest trees the trouble appears to be confined to one branch only, while in citrus trees the whole tree becomes invaded. The species most subject to the disease is the lemon, but the comparative immunity of the orange may be simply the result of its less intense cultivation in Sicily.

Normally, the disease affects trees of a somewhat advanced age, the youngest recorded case being a tree that had been grafted six years before. It develops slowly, but the rate of progress is faster in some years than in others. Once established in a branch it proceeds to invade others until after some years the whole tree is affected.

At the beginning, the foliage shows the symptoms of chlorosis, and the individual leaves sometimes tend to become elongated. The cortex dries up and is detached with difficulty, and at this stage some degree of sterility may result. On the branches the beginnings of the disease are marked by the formation of hypertrophied tubercles in many of the buds, which if able to produce shoots at all, give only very small ones. The apical portion of the affected branch is also atrophied. During the second stage the hypertrophy becomes intensified and many of the buds are killed by constriction, while the apex and lateral shoots produced by an affected branch are normally atrophied but may be hypertrophied. On the hypertrophied twigs, the leaves are generally small and malformed and any lateral branches borne are weak and stunted. The third phase is the formation of the 'broom' by the production of single twigs from one or more of the swollen buds and the development of secondary lateral branches, more or less crowded together, on these. This period of vigour is followed by the gradual decay of the twigs forming the 'broom', which wilt and become atrophied. Lastly, twisted branches with large sterile tubercles are left, which give the tree an enfeebled appearance.

Lemons on diseased trees develop in a characteristic manner; the navel becomes somewhat elongated and the fruit itself, from being ovoid or subrotund assumes an elongated oval form, while the smooth rind becomes roughened. There is no great difference in the acid and sugar content of lemons from healthy and diseased trees, but an increase in acid and a decrease in sugar become more noticeable as the disease progresses, as is usual in troubles affecting citrus trees.

The cause of this malformation is unknown, and the only proved remedy is the cutting away of affected branches as soon as they are noticed.

JANINI JANINI (R.). **The chief diseases and pests of the Orange and Lemon groves in Spain.**—*Intern. Rev. of the Sci. and Pract. of Agric.*, N.S., i, 1, pp. 61–73, 2 pl., 1923.

The chief fungous diseases of citrus trees and fruit in Spain are said to be those caused by the following fungi:—*Agaricus citri* Inz. ('mal de caña'), *Polyporus obliquus* Fr., *Meliola citri* Br. ('mal de ceniza'), *Meliola penzigi* Sacc. (*Fumago vagans* Pers.), *Cladosporium fumago* Link, *Dematium monophyllum* Ris., *Capnodium citri* Mont., *Morphea citri* Catt. ('negrilla' &c.), *Physalospora citricola* Penz., *Sphaerella gibelliana* Pass., *Melanomma medium* Sacc., *Pleosphaeria hesperidum* (fruit spot), *Sphaerium wolffensteiniani* Kühn ('mal de goma' &c.), *Aposphaeria sepulta* Penz., *Colletotrichum gloeosporioides* Penz., *Oospora hyalinula* Sacc., *Penicillium glaucum* Link., *P. digitatum* Sacc., *Botrytis vulgaris* Fr., *Echinobotryum citri* Gar., *Cladosporium herbarum* Link., *Fusarium limonis* Br. and *Rhizoctonia violacea* Tul.

Of these the most dreaded are 'negrilla' and 'mal de goma' (gummosis). The latter is usually controlled by cutting the main root of the tree and uncovering the large roots to a distance of 25 cm. from the trunk. A circular trench is dug round the tree to prevent the irrigation water reaching the trunk. Another method is to apply

powdered iron sulphate every three, four, or five years. The chemical is spread on the soil at the rate of 600 to 1,200 kg. per hectare and dug in like other fertilizers.

The chief insect pests are described in some detail and a bibliography of Spanish references is appended.

BARTHOLOMEW (E. T.), BARRETT (J. T.), & FAWCETT (H. S.). **Internal decline of Lemons. I. Distribution and characteristics.**—*Amer. Journ. of Botany*, x, 2, pp. 67–70, 1 pl., 1923.

The term 'internal decline', as used in the present article, includes 'blossom end decay', 'tip deterioration', 'yellow tip', 'dry tip', and other local names applied to the same trouble. The indications are that the disease, which is particularly prevalent in the hot inland valleys of southern California, is increasing in severity. All varieties of lemon appear to be more or less susceptible, and trees of any age from three to fifty years may be attacked. The highest percentage of infection is usually found in the so-called 'tree-ripe' fruit, i.e., the lemons which remain on the tree until they have attained their mature yellow colour, but in severe cases the green fruit may also be seriously damaged. The disease may be found at almost any time of year from June onwards.

The external symptoms of the disease are by no means infallible, but in most cases the development of an intensive orange-yellow colour at the stylar end of the fruit denotes the initial stages of an abnormal breakdown of the internal tissues, and at a later stage, in ripe fruit, a depression often appears in the rind at the stylar end. The internal symptoms, which vary considerably in green, silver, and ripe fruit, consist of the collapse of the parenchymatous cells at the stylar end, the clogging of the vessels in the peel at this end with a pinkish to rust-brown deposit of gum, and a loss of water from the neighbouring tissues, including the cells of the fruit pulp below the apex. This loss extends gradually deeper in towards the centre of the fruit and may ultimately result in the drying out and collapse of the pulp involving a third or half the fruit at the distal end.

BARTHOLOMEW (E. T.). **Internal decline of Lemons. II. Growth rate, water content, and acidity of lemons at different stages of maturity.**—*Amer. Journ. of Botany*, x, 3, pp. 117–126, 1923.

A series of experiments was conducted at Corona, Upland, and Riverside (California), on Eureka lemon trees of varying ages, to determine the possible bearing on the etiology of internal decline [see last abstract], of (*a*) the rate of increase in size, as influenced by climatic and seasonal changes and the time of year at which the fruit is set, and of (*b*) the increase in acidity and water content of the fruits at different stages of development. The results of the tests, details of which are given, showed that, while the Eureka lemon tree tends to a continuous production of new fruit, the age of the tree and climatic and soil conditions render such production more or less seasonal, especially in the inland regions.

Climatic and seasonal factors determine the growth rate of the fruits some of which mature in seven or eight months, while others

on the same tree require fourteen months. The time of the year when the fruit sets and the position on the tree also affect the growth rate. Lemons may actually decrease in size while still attached to the tree in consequence of the withdrawal of water by the leaves, and this may result in the collapse of a portion of the tissue in the stylar end of the fruit. The lemon fruit in fact acts as a water reservoir for the leaves. The wilting coefficient of the soil as indicated by the leaves is not a reliable criterion as to the adequacy of the water supply to the fruit. The water contents of the two ends of the normal lemon are practically identical. The water content increases rapidly until the lemon has attained a diameter of about 3·8 cm., and then more slowly until the fruit reaches maturity. The size of the lemon is not necessarily proportional to the percentage of water it contains. In the young fruit the percentage of water depends to a considerable extent on the available supply of water to the roots. The variation in the water content of the mature lemons under observation in the experiments ranged from 88·20 to 92·14 per cent.

The total acid content of the lemon increases rapidly with increasing size, but there is a very slight increase in the true acidity of the juice after a diameter of 3·8 cm. has been attained. The examination of a large number of normal lemons showed that in spite of some wide variations, the average degree of acidity was substantially the same in the stylar and stem ends. Ripe lemons of approximately the same age and size exhibited a comparatively wide range of acidity, the average for all tested being P_H 2·31.

WINSTON (J. R.) & BOWMAN (J. J.). **Commercial control of Citrus melanose.**—*U.S. Dept. of Agric. Circ.* 259, 8 pp., 1923.

As a result of numerous spraying experiments and of field observations by commercial growers, the authors state that, under Florida conditions, melanose of citrus fruits (*Phomopsis citri*) is readily controlled by one or two applications of standard 3–3–50 Bordeaux mixture plus one per cent. oil in the form of emulsion; in an average season the treatment should be completed by 5th May. Comparative tests with other preparations showed that weaker Bordeaux mixture and other weak copper sprays are not as effective as the one recommended. The formula and instructions for the preparation of the mixture are essentially the same as previously described [see this *Review*, ii, pp. 363 and 364] except that the oil emulsion recommended is made by boiling 2 gall. paraffin oil, 1 gall. water, and 2 lb. fish oil soap together and pumping the hot liquid into another vessel and back again. Sulphur sprays as a class and copper or sulphur dusts have not thus far proved satisfactory for the control of melanose. Thorough pruning of the dead wood (which has been recommmended for a number of years as a means of controlling melanose in a normal mature grove) has not been found commercially practicable in view of the high cost and slowness of the work, and careful experimental trials made in 1921 and 1922 did not give satisfactory results as little or no control of the disease was effected. Prunings on the ground and fallen fruit did not appear to be a source of melanose infection. When melanose is controlled, stem end rot of the fruit is reduced. Treatment against

melanose should be followed by spraying against insect pests and other fungous diseases.

SMALL (W.). **The diseases of Coffea arabica in Uganda.**—*Uganda Dept. Agric. Circ.* 9, 22 pp., 1923.

This account of the principal fungous diseases of coffee in Uganda has been prepared mainly for the use of planters and agricultural officers. Technical details have been omitted as far as possible, the symptoms of the diseases and the life-histories of the causal organisms being briefly described in popular language. The amelioration and prevention of the local diseases of coffee are much more feasible than their cure. The suggested control measures are therefore based mainly on an improvement in the environment of the trees, the general condition of which is too frequently below par in Uganda.

Coffee leaf disease (*Hemileia vastatrix*) is common on *Coffea arabica*, especially in the absence of shade. Direct control of the disease by spraying is, in the writer's opinion, impracticable in Uganda. The cost is prohibitive and the results uncertain. Indirect control measures include the planting of the trees in small blocks isolated by wind-breaks, arranged in such a way that the prevailing winds sweep them crosswise rather than lengthways; wide planting; the burying of fallen diseased leaves; the selection of dry sites for nurseries, and the provision of suitable shade. Overbearing should be prevented by stripping. Some system of pruning to lighten overburdened trees is necessary, and it is hoped that the multi-stem experiments now in progress will be continued.

The leaf spot and berry blotch due to *Cercospora coffeicola* also occurs principally in the open and may be largely controlled by the provision of shade trees. The destruction of infected leaves and berries and a series of spray applications with Bordeaux mixture while the berries are ripening are also recommended.

Brown blight of leaves and berries (*Colletotrichum coffeanum* = *Glomerella cingulata*) may be adequately controlled by due attention to shade and other cultural methods.

Sooty mould (*Capnodium brasiliense*) is in itself more unsightly than harmful and is important chiefly as indicating the presence of the scale insects with which it is associated. The fungus is dependent on the honey dew secreted by these insects and disappears when they are destroyed. Attacks of sooty mould have been infrequent of recent years.

Defective beans, usually termed 'lights' or 'floaters', may be due to any one of the following causes, or to a combination of several: *Hemileia* leaf disease, prevalence of die-back, *Colletotrichum* blight, *Cercospora* blotch, variegated bug, or unfavourable weather conditions during ripening. The variegated bug has been proved to be implicated in the introduction of a species of *Phoma* into the tender tissues of the young beans by means of spores carried in or on the beak with which it punctures the 'cherries'. The fructifications of the *Phoma* can afterwards be found on the cured beans, where their presence and development add considerably to the direct harm caused by the insect. The

provision of shade and attention to other cultural measures will greatly reduce the proportion of defective beans.

Anthracnose of branches may be due to a variety of causes besides the direct attack of the fungus *Colletotrichum coffeanum*, which was conclusively proved in 1919 to be mainly saprophytic. *Hemileia* leaf disease frequently leads to the dying back of branches, while insect attacks and sun scorch are also often responsible. The use of the terms 'large scale die-back' and 'small scale die-back' has given rise to some confusion, which will in future be avoided by referring to the former as die-back proper and to the latter as anthracnose.

Die-back proper is the result of a disturbance in the normal physiological balance of the plant and is confined to the older trees. Its prevalence in Uganda is believed to be largely due to the errors of cultivators which accompanied the commercial rise of coffee-growing from 1910 onwards. The choice of unsuitable sites, and the neglect of pruning and other cultural operations resulted in serious losses. To-day the disease is less in evidence on account of the gradual spread of scientific knowledge, and it should be possible to reduce it to a minimum by proper care. The selection of healthy seed, thorough weeding, mulching and fertilizing, and the provision of shade are among the most important preventive measures. *Hemileia* is an important factor in the production of die-back, and the measures recommended for the control of the former will contribute to the prevention of the latter.

Witches' brooms, the cause of which is unknown and may possibly be an insect or a parasitic fungus, are uncommon on coffee in Uganda. Affected branches should be burnt.

Brown root disease (*Fomes lamaoensis*) [see this *Review*, ii, p. 291] is somewhat rare, being generally restricted to isolated young trees. The degeneration which it causes is sometimes so gradual as to be imperceptible until the collapse of the affected trees in a storm reveals the decay of the lateral roots. The following preventive measures are recommended: (1) isolation of the infected area by a trench one to three feet in depth; (2) removal of the diseased trees and all broken fragments of roots; (3) disinfection of the soil by exposure to sun and air and the working in of lime or a soil fungicide.

Root rot (*Armillaria mellea*) produces symptoms similar to those of brown root disease and may be controlled in the same manner. The scarcity of both these diseases on Uganda coffee is largely attributable to the fact that elephant grass land rather than forest was used for planting.

Mealy bug root disease (*Pseudococcus citri* and *Polyporus coffeae*) is very prevalent in old native gardens, the mealy bug (which the author regards as the dominant and earlier partner in the association) occurring on a number of indigenous crops. *Polyporus coffeae* has not yet been found as an independent parasite of coffee, and is not known to occur on any other plant or in any country except Uganda. Apart from the insect, therefore, the fungus appears to be only very weakly, if at all, parasitic. Further investigations, however, are necessary to determine the exact nature of the relations between the two.

SCHIKORA (F.). **Ueber die Krebspest und ihren Erreger, Aphanomyces magnusi Schikora.** [On the Crayfish plague and its cause, *Aphanomyces magnusi* Schikora.]—*Verhandl. Bot. Vereins Prov. Brandenburg*, lxiii, pp. 87–88, 1922.

This paper, read before the Botanical Society of the Province of Brandenburg in September 1920, deals with the results of an investigation lasting many years into a disease affecting crayfish. The crayfish fisheries of Germany are of considerable importance, the yearly value of the catch in German waters amounting to 100,000,000 marks [then worth about £800,000]. The disease itself, the cause of which has been the subject of much controversy, is stated now to have almost disappeared. Hofer's hypothesis that the *Bacterium* which he named *Bact. pestis astaci* must be held responsible has not been borne out by tests undertaken by both the German Ministry of Health and the Hygienic Institute, while his opinion that the organism in question acquired its first virulence in factory waste waters in Belgium is also controverted by the present author. It is stated that attempts to demonstrate the action of an ultra-microscopic virus failed.

The author is of opinion that the original focus of infection was at Gambara, in Italy, whence the disease spread through western and north-western France, northern Germany and Russia to Siberia. Another path can be traced along the Danube depression to the Black Sea. The dissemination of the disease appears to have taken place within a period of forty years, and indications—stated to have been neglected by other investigators—pointed to the pathogenicity of a species of the Saprolegniaceae which the author found in 1902, and named *Aphanomyces magnusi*. This fungus is said to be absent in healthy animals, and to be able to produce the typical symptoms of the disease on inoculation. The failure of other workers to recognize its causal relations to the disease is considered to be due to the extraordinary complexity of the symptoms which it can produce. American Cambaridae are stated to be immune.

GREENBAUM (S. S.). **On the biologic properties of pathogenic molds.**—*Journ. Infect. Diseases*, xxxi, pp. 26–31, 1922.

The work recorded in the present paper was undertaken with the following objects: a study of the proteolytic and amylolytic ferments of 26 pathogenic fungi; their action on various sugars and on litmus; a study of indol production; and a study of the toxins of several species.

The results of experiments conducted under uniform conditions to ascertain the comparative proteolytic properties of the fungi in 10 cc. of 10 per cent. gelatine showed that complete liquefaction was obtained in 24 hours with two species of *Trichophyton* [which are named], with *Microsporon pubescens*, and *Achorion quinckeanum*; moderate liquefaction in the same period with three species of *Trichophyton* and *Sporotrichum beurmanni*; and slight liquefaction with eight species of *Trichophyton* and *Microsporon lanosum*. No liquefaction was obtained with *Trichophyton rosaceum*, *Microsporon audouini*, *M. fulvum*, *Sporotrichum gougeroti*, *Actinomyces boris*, *Achorion schoenleinii*, and *A. gallinae*. The ring-worm fungi in this group, however, caused liquefaction at a later stage.

Both Truffi and Roberts showed that liquefied gelatine was able to hold and transmit the proteolytic body, but this was not always true for the organisms in the present study. In several cases when the filtered liquefied gelatine was placed in contact with fresh gelatine no liquefaction of the latter was caused. When the liquefied gelatine possessed a definite enzymic power, this was found to vary in activity according to the organism which had produced it. Whereas in some cases the fresh gelatine was liquefied in 24 hours with a given quantity of the liquefied material, others required 48 hours to complete the process. The variation in the activity of the gelatinase with the organism was due less to the rapidity with which the latter grew than to the quantity or quality, or both, of the gelatinase.

The author was unable to detect sugar with Benedict's solution at any time during the two months of the growth of the fungi in a starch-water medium. They grew well in 3 and 5 per cent. starch solutions, indicating their capacity to assimilate the larger starch molecule without previous hydrolytic changes.

For the study of sugar fermentation and litmus reaction a Russell's modified double sugar medium prepared with lactose and glucose was used, together with a series of tubes each prepared with one only of the following: lactose, glucose, maltose, saccharose, dextrine, or levulose. The fungi grew well on these media, but lacked the characteristics given by Sabouraud's concentrated and proof media. None of 15 species of *Trichophyton*, 4 of *Microsporon*, and 4 of *Achorion* tested altered litmus or caused fermentations of any of the sugars. The same organisms grown on identical media without peptone also failed to ferment any of the sugars used.

Böhme's technique (*Journ. Amer. Med. Assoc.*, lxxvii, p. 959, 1921) was used for indol production, the organisms being planted in sheep serum broth. Indol could not be detected in any of the implants, some of which, however, failed to grow.

Toxin production was studied in *Trichophyton acuminatum*, *T. gypseum asteroides*, *Microsporon audouini*, *Sporotrichum beurmanni*, and *Achorion schoenleinii*, cultivated in a proof medium with bouillon as a base and sealed to prevent evaporation. The *Trichophyton* spp. and *Sporotrichum* were grown for eight weeks, the others for fourteen, and the cultures were then filtered through sterile filter paper and a sterile Kitasato candle. A control flask of the medium was filtered in the same way. Intraperitoneal injections into eight guinea-pigs with 4 cc. of each medium proved fatal with the *Trichophyton* spp. and *Achorion*, but gave negative results with the others. Death supervened in 24 hours after injection, with *T. acuminatum*, in 10 days with *T. gypseum asteroides*, and in 12 days with *Achorion schoenleinii*. A post-mortem examination revealed a marked suprarenal vascular disturbance resembling that produced by the intraperitoneal injection of diphtheria toxin. Cultures made from the peritoneal fluid remained sterile.

Departmental Activities: The Schools of Agriculture and Experiment Stations.—*Journ. Dept. Agric. S. Africa*, vi, 3, p. 205, 1923.

Grasshoppers of several species in the vicinity of Cedara were

decimated in December 1922 and January 1923 by a severe epizootic of a fungous disease caused by *Empusa grylli* Fresenius. The diseased individuals exhibited the characteristic habit of crawling to the top of the grass to die. This circumstance facilitates the dissemination of the conidia, which are produced in abundance on the surface of the insect a few hours after death and thrown off on to the surrounding foliage, thus infecting other grasshoppers. In some areas nearly every blade of grass bore a victim. Prolonged periods of low evaporation being necessary for the best development of the fungus, its scarcity in the preceding season may be explained by the drier weather in December 1921 [see also this *Review*, i, p. 391].

Weather conditions were also responsible for the relatively mild attack of *Entomophthora megasperma* Cohn on the two worst South African species of cut-worm in 1922, as compared with its virulence in the preceding year, the early rainfall of 1921, in the wet season, when cut-worms are most numerous, being absent in 1922.

LE MOULT (L.). **La destruction des insectes nuisibles par les parasites végétaux.** [The destruction of injurious insects by vegetable parasites.]—*Rev. de Bot. appliquée*, iii, 18, pp. 84–102, 1923.

The author gives an account of his earlier work in connexion with the formation in various parts of France of syndicates for the destruction of cockchafers [see this *Review*, i, p. 355]. The work was accomplished by the ordinary methods known at that period (1889), namely, the capture of the insects when stupefied by dew and the collecting of larvae after ploughing.

Altogether, over 5,000,000 kg. of cockchafers were destroyed during the seven years over which the work extended. It was obvious, however, that such primitive methods had serious drawbacks. They could not, for instance, be employed in seasons when ploughing was delayed, since the insects burrow into the soil at the first sign of cold weather; they were also useless in fields bearing perennial crops, such as lucerne.

In 1890 the author became acquainted with the work of the Russian professor, Krassilstschik, a pupil of Metchnikoff, who, in 1884, had constructed a small experimental factory at Smela (Kiev) for the artificial production of the fungus *Metarrhizium anisopliae*, parasitic on *Cleonus punctiventris*, a serious pest of sugar beets. In four months 55 kg. of pure spores of the fungus were produced on maize beerwort at a temperature of 25° [C.], 1 sq. m. of the liquid yielding 189 to 200 gm. of spores at each collection, which took place fortnightly. By this method sufficient spores were obtained to cause epidemics which destroyed from 55 to 80 per cent. of the insects in small areas in 10 to 15 days.

In 1890, on an estate in the Orne Department, the author found numerous mummified larvae of cockchafers, some of which were covered with a pink growth of *Beauveria densa* (*Isaria densa* Giard). In 1891 and 1892 he used cultures of this fungus on infested soil with great success; one field was estimated to contain over 20,000 mummified larvae after treatment. The cultures take some time to produce the necessary effects (from the autumn to the spring in certain cases), but their influence is of long duration. The

fields treated in 1890 are still exempt from the insects. The average quantity of spores required per hect. is 5 kg., which is mixed with 1 hectol. of soil and scattered broadcast immediately before ploughing. The rest of the work is accomplished by natural means. In meadows and plantations it is necessary to raise the grass or dig holes for the insertion of the cultures.

The author is convinced that *Isaria farinosa* (the conidial stage of *Cordyceps militaris*) can be substituted for *Spicaria verticilloides*, which is considered by some to be only a variety of the former [and is sometimes known as *Spicaria farinosa* var. *verticilloides*], in the control of the *Cochylis* and *Eudemis* of the vine. *Beauveria globulifera* (*Sporotrichum globuliferum*), which is employed in the United States against *Blissus leucopterus*, is probably adapted also to the control of the vine *Phylloxera*.

From Holland cultures have been received of *Cladosporium aphidis* which will probably be efficacious in the control of plant lice, and will be tested against *Phylloxera*. *Schizoneura lanigera* and other insects with subterranean colonies can in all probability be controlled by inoculation of the soil with *B. globulifera*, which, in 1916, completely destroyed these insect pests on the author's apple trees. This method is more permanent than merely spraying the trunk and branches with a suspension of the spores. In 1892 larvae of what appeared to be *Elater segetis* infested by *B. globulifera* were received from Nantes. In general the author believes that all soil-dwelling pests are likely to yield to treatment with a suitable fungus. His laboratory now contains cultures of thirteen entomogenous fungi, further experiments with which on various insects are in progress.

The cultures for field use are made chiefly on potato and carrot, and should be broken up and mixed with sand or mould before spreading on the soil prior to ploughing in. Care must be taken to keep free from contamination the cultures used for inoculating the flasks in which the fungus is multiplied on a large scale; impurities in the latter, unless such as are obviously visible, are of less importance, since no further cultures are made from them. The essential point is to use really large quantities of the fungus, small doses being too uncertain in their effects, and this can only be done by adequate organization.

NAKADA (N.) & TAKIMOTO (K.). **Bacterial blight of Hibiscus.**—*Ann. Phytopath. Soc. Japan*, i, 5, pp. 13–19, 1 fig., 1923. [In Japanese, with English summary.]

An undescribed bacterial leaf spot of *Hibiscus* has been under observation in Korea since 1913. The disease, which affects the cotyledons of young plants when two to three leaves are expanded, first appears in the form of minute, circular, black spots which gradually increase in size, the margins finally becoming angular. The edges of the spots assume a whitish-yellow tinge or water-soaked appearance, and when the leaves are severely attacked the whole plant becomes blackened and withered. The causal organism (*Bacterium hibisci* n. sp.) has been isolated and its pathogenicity proved by inoculation experiments. It is a cylindrical rod with rounded ends, occurring singly, in pairs, or concatenate, 1·2 to 2 by

0·6 to 0·7 μ, motile by means of one or two polar flagella, forming no spores Gram negative, staining readily in carbol fuchsin, aniline water, gentian violet, and aqueous methylene blue; surface colonies on agar smooth and circular, slightly elevated in the centre and finely granular under magnification, shiny and cement-coloured by reflected light; bouillon culture clouded after 20 hours at 25° to 27° C.; gelatine slightly liquefied, milk slowly peptonized, no gas produced, nitrate slightly reduced, no reaction of indol, thermal death point 42° C., aerobic.

The results of an experiment in seed disinfection carried out in April 1921 showed that the plants grown from seed treated with mercuric chloride 1 in 1,000 or hot water (55° C.) for ten minutes remained healthy, while those in the untreated control plots developed 50 per cent. of disease. The organism is thus proved to be capable of overwintering on the seed. The application of a 5–5–50 spray of Bordeaux mixture was found greatly to reduce the incidence of infection.

TELLEZ (O.). **Una plaga en el estado de Jalisco: La 'pinta' o 'clavo' de la naranja y de la guayaba.** [A pest in the State of Jalisco: The 'spot' or 'knob' disease of the Orange and the Guava.]—*Rev. Agric. (Mexico)*, vi, 11, pp. 651–652, 2 figs., 1922.

This disease, caused by *Glocosporium psidii*, is very common in the State of Jalisco, Mexico. The brown, coriaceous, circular spots, from 1 to 4 mm. in diameter, form crusts on the rind of the fruits and penetrate to a depth of 7 or 8 mm. In the case of the guava, they are so numerous that they may cover the whole of the skin, but they are more scattered on the orange.

In the control of the disease the following measures are stated to give good results:—Spraying with Bordeaux mixture (2·76 kg.–2·76 kg.–200 litres) every fortnight, beginning just before the fall of the petals and ending when the fruits are nearly ripe. All fallen leaves must be burnt and the ground under the trees kept clean. Each tree requires from 4 to 5 litres of the spray mixture, one man being able to treat 100 trees per day. After picking it is well to wash the fruits in a 9 per cent. solution of vinegar, and then they must be rinsed in fresh water and placed to dry on reed mats.

HOPKINS (E. F.). **The Sphaerulina leaf-spot of Clover.**—*Phytopath.*, xiii, 3, pp. 117–126, 2 pl., 3 figs., 1923.

A disease of white clover (*Trifolium repens*), new to America, was observed by the author at Missouri in 1920 and subsequently identified as *Sphaerulina trifolii* E. Rostr. The loss caused by it is probably not great, although it may cause some defoliation.

The first symptom is the appearance of minute, black lesions on the leaves, petioles, and stipules. Later these spots enlarge and have a light brown to grey centre, surrounded by a dark reddish-brown margin; they bear perithecia, especially under moist conditions, the infected tissue becoming water-soaked.

The morphology of the fungus is described, the ascospore measurements being 30·4 to 39·5 by 12·2 to 15·1 μ.

Numerous isolations of the fungus were made. On potato agar

the colonies were white at first and then gradually became black, except for a white border. The black structures failed to show any asci or pycnospores. When growing actively the cultures have a pleasant fruit-like odour.

Inoculation experiments with pure cultures were not very successful, but in one case strong infection was obtained on mammoth clover (*T. pratense perenne*), medium infection on white clover, and slight infection on red clover (*T. pratense*). Re-isolations were successfully made. By suspending leaves bearing perithecia over healthy plants under a bell jar, infections were obtained without difficulty. A table is given showing the relative susceptibility of eight different clovers, of which mammoth clover appears to be the most susceptible.

The first case of infection in 1922 was observed on 17th March after heavy rain. The germ-tubes from the ascospores penetrate the epidermis directly, sometimes after growing some distance. No appressoria were observed, but the empty walls of the ascospore persist for some time after infection has taken place.

BONANNI (A.). **La tubercolosi o rogna dell' Olivo.** [Tuberculosis or scab of the Olive tree.]—*Le Staz. Sper. Agr. Ital.*, lvi, 1–3, pp. 124–144, 2 pl., 1922.

In this paper the results are given of a detailed study of the olive knot disease caused by *Bacterium savastanoi* E. F. Smith, with which the author has frequently found various other bacteria as well as budding and filamentous fungi, all of which are regarded as incidental invaders of the tumours. Inoculation experiments were carried out which prove the pathogenicity of *Bact. savastanoi* and the inability of the other organisms mentioned to cause infection. The morphological and cultural characters of the pathogen are described. It was found to have peritrichous flagella instead of the one to four polar flagella described by E. F. Smith, but the author does not attach much importance to this discrepancy, which he thinks may be due to the staining technique employed.

In agreement with Schiff-Georgini, the author distinguishes between the primary tubercles resulting directly from the entrance of the causative agent through lesions, and the secondary tubercles produced by metastasis in which vessels are the path through which the infection is transmitted, while the tegumentary tissues remain perfectly sound. The first type occurs always on young twigs, where the younger tissues favour bacterial development. In this case the bacterial cavity is situated in the cortical tissues and there is a hyperplasy of the bark. From the cortex the infection spreads to the central cylinder and through the woody layers to the pith. On reaching the vessels more extensive diffusion of the organism commences and the second form, the metastatic tubercle, is produced. In this type infection starts from the vessels and proceeds tangentially and radially from the infection centre. The bacterial cavities are found only in the wood and the cell prolification causes the rupture of the cambium and bark layers as the tubercle increases in size.

The conditions which predispose to the disease are stated to be

sometimes connected with the soil, sometimes climatic, and sometimes to depend on the constitution of the plant. Insects may be carriers of the organism and wounds allow infection to take place.

MIYAKE (C.). **On a brown shot hole disease of Cherry leaves caused by Mycosphaerella cerasella Aderh.**—*Ann. Phytopath. Soc. Japan*, i, 5, pp. 31–42, 1 pl., 1923. [In Japanese, with English summary.]

Investigations on *Mycosphaerella cerasella* Aderh., which causes the brown shot-hole disease of the cherry (*Prunus cerasus*) and also of *P. yamasakura* var. *typica*, *P. yamasakura* var. *spontanea* subvar. *hortensis*, *P. itokasura*, and *P. itokasura* var. *subhirtella*, in the west of Japan, were carried out at the Ohara Institute, Okayama. The genetic relation between *Cercosporella cerasella* Sacc. and the *Mycosphaerella* was demonstrated by comparative cultural studies of the isolations secured from both the ascigerous and conidial stages, the morphology of which are described in Japanese and illustrated by excellent figures. The parasitic nature of *M. cerasella* was determined by successful inoculations carried out on the above mentioned varieties of cherry.

MÜLLER (H. C.), MOLZ (E.), & MÜLLER (K.). **Einige Ergebnisse unserer Beizversuche 1921–22.** [Some results of our disinfection experiments 1921–22.]—*Deutsche landw. Presse*, l, 6, pp. 48–49, 3 figs., 1923.

The authors have carried out extensive experiments with the following preparations, the value of which they consider may now be regarded as definitely established.

Against bunt of wheat caused by *Tilletia* [*tritici*] formaldehyde (40 per cent., immersion for 15 minutes in a 1 in 400 solution) gave, on the whole, very good control, but its injurious effects on germination and subsequent vigour of the plants were undeniable. The treated plants also suffered considerably from frost. Germisan (immersion in 0·25 per cent. for 15 or 30 minutes; or sprinkling, 0·5 and 0·75 per cent., 15 litres of solution per 100 kg. of wheat, covered for 8 hours) gave very good protection. The stand was normal and some of the plots considerably above the average. Weizenfusariol (applied according to directions) controlled the disease very well both with immersion and sprinkling. In the latter method the seed should be washed before sprinkling to ensure good results. Uspulun (0·5 per cent. immersion for one hour) was very satisfactory, but the 0·25 per cent. solution proved inadequate. The results of sprinkling were conflicting, but in one case, when the seed had been previously washed, they were very good. The growth of the plants was excellent. Kalimat, the active principle of which is an unstable compound of phenol and formaldehyde, has all the advantages of the latter without its drawbacks. Good results were obtained both by immersion (0·25 per cent. for 30 minutes) and sprinkling (0·33 per cent.)

Against the stripe disease of barley due to *Helminthosporium* [*gramineum*], germisan (immersion in 0·25 per cent. for one hour or sprinkling with 15 litres of the solution at a strength of 0·75

per cent., 8 hours covered) gave the best results. In some cases it was necessary to immerse in a 0·5 per cent. solution and even then the disease was not absolutely controlled. The growth of the treated plants was extremely satisfactory. Uspulun (0·5 per cent., immersion for two hours) also gave good results, but failed to control the disease entirely.

Against the snow *Fusarium* [*F. nivale*] of rye, germisan (0·25 per cent., immersion for one hour) gave almost complete control of the disease, the number of ears in the treated plants being nearly double that of the untreated. Sprinkling at the same strength also gave good results. Roggenfusariol (used according to directions) was equal to germisan. Uspulun (immersion for one hour in 0·25 per cent.) gave satisfactory results. In the sprinkling method (50 gm. per 15 litres of water) the effect was slightly weaker but still adequate. 778 (immersion for 15 minutes in 0·75 per cent.) gave very satisfactory control.

Against the flag smut of rye due to *Urocystis* [*occulta*], the results obtained have already been published [see this *Review*, ii, p. 170]. In addition to the preparations therein mentioned, 778 (0·5 per cent. immersion for 15 minutes) gave very good control.

Against the loose smut of oats, caused by *Ustilago* [*avenae*], formaldehyde (40 per cent., immersion for 15 minutes in 1 in 400 solution, or sprinkling with 20 l. of 1 in 200 solution per 100 kg. of oat seed, covered for 2 hours) gave excellent control of the disease. In most cases the stand of the crop was satisfactory. Germisan (immersion for 30 minutes in 0·25 per cent. solution or sprinkling with 30 l. of 0·75 per cent. solution per 100 kg. of oat seed) gave excellent control and vigorous growth. Sublimoform (used according to directions) effectively controlled the disease, but somewhat impaired germination and energy. Kalimat (immersion for one hour in 0·25 per cent. or sprinkling with 20 litres of 0·3 per cent. solution per 100 kg. of seed) gave absolute control of the disease and improved the appearance of the stand.

It is pointed out that, owing to the depreciation of the German currency, the cost of germisan and other mercurial preparations will soon become prohibitive, while kalimat, being manufactured from home-produced raw materials, is readily obtainable at a reasonable price. It is a first class fungicide, especially for the control of bunt of wheat, loose smut of oats, and flag smut of rye, and causes no injury to germination.

MORSTATT (H.). **Bibliographie der Pflanzenschutzliteratur: das Jahr 1922.** [Bibliography of plant protection literature published in 1922.]—*Biol. Reichsanst. Land.- und Forstwirtsch., Berlin-Dahlem*, 162 pp., 1923.

This comprehensive bibliography of the literature published during 1922 relating to the various aspects of plant protection is divided into the following four sections, each of which is further sub-divided into appropriate groups: general; diseases and causes; host plants; plant protection measures (comprising legislation, administration, statistical information, and preventive and curative methods).

RAO (K. A.). **A preliminary account of symbiotic nitrogen fixation in non-leguminous plants, with special reference to Chomelia asiatica.**—*Agric. Journ. India*, xviii, 2, pp. 132–143, 2 figs., 1923.

The author in this preliminary paper adds another plant, *Chomelia asiatica*, to the list of species which bear nitrogen-fixing bacteria in nodules on their leaves. Von Faber (*Jahrb. Wiss. Bot.*, 51, p. 285, and 54, p. 243) investigated the symbiotic relationships of the bacteria in the leaf nodules of five species of Rubiaceae, and showed that they had the remarkable property of fixing nitrogen from the air. Miehe (*Ber. d. Bot. Ges.* 34, p. 576), working on the Myosinaceae, came to similar conclusions.

Chomelia asiatica, a Rubiaceous shrub, bears ten to twelve generally round and rarely irregular bacterial nodules on each leaf, situated at the junction of the veins with the midrib. *Pavetta indica*—previously described by von Faber—was studied for purposes of comparison. Stomata serve as points of entry, from which the bacteria pass into the intercellular spaces, and penetrate therefrom between the cells, causing the latter to divide vigorously. A special nodule tissue is thus formed, with the result that the leaf swells on the affected side. In older stages liquefaction of the nodule tissue was noticed, possibly owing to digestion of the bacteria by the host.

The organism was isolated by inoculating nitrogen-free mannite solution [see Ashby, *Journ. Agric. Science*, ii, p. 38] with an emulsion of teased nodules. The liquid medium recommended by von Faber was also used. After subculturing five times on the liquid medium the organism was plated on the gum arabic agar medium of von Faber. The colonies develop slowly on this solid medium, and are extremely small, milky white, opalescent, thin, round, and of a gummy consistency. The bacteria stain well with ordinary stains. They prefer an alkaline reaction and plenty of air. Their nitrogen-fixing capacity was tested from cultures in Ashby's medium.

The bacteria are most active at growing points in the leaf primordia of unopened buds, but they can be found between the embryo and the endosperm of the seed, and apparently also in the vegetative apex of the embryo. Successful cultures were obtained from seeds, leaf buds, and ovaries. During germination the bacteria can be found in the growing points. The infection is thus evidently hereditary. Pot culture experiments are in progress to ascertain whether the bacteria are necessary for plants of *Chomelia asiatica* to thrive, as is said to be the case with *Pavetta indica*.

The nitrogen content of the leaves of these plants must be large, and the author suggests their application in large quantities as a manure, a practice which appears to be in vogue already among the Tamil cultivators of Ceylon.

WEIMER (J. L.) & HARTER (L. L.). **Pectinase in the spores of Rhizopus.**—*Amer. Journ. of Bot.*, x, 4, pp. 167–169, 1923.

The results of experiments with the ungerminated spores of *Rhizopus tritici* and *R. nigricans* showed that both species contain an enzyme, pectinase, which is capable of dissolving the middle

lamellae of sweet potatoes. The rate of action of the enzyme was tested by immersing raw sweet potato disks in a suspension of spores treated so as to prevent germination. That of the spores of *R. tritici* was comparatively rapid, the raw sweet potato disks being completely macerated in twenty-four to forty-eight hours. *R. nigricans*, on the other hand, acted very slowly, taking seventy-two hours or longer to accomplish maceration. This is in harmony with the authors' previous results regarding the activity of the enzymes of these two fungi [see this *Review*, i, p. 273].

It is probable that pectinase plays an important part in the early nutrition of the fungus, while it may also be a factor in the initial infection of some of its hosts.

HARTER (L. L.) & WEIMER (J. L.). **Amylase in the spores of Rhizopus tritici and Rhizopus nigricans.** — *Amer. Journ. of Bot.*, x, 2, pp. 89-92, 1923.

The results of experiments in the growth of *Rhizopus tritici* and *R. nigricans* at various temperatures showed that the former produced spores in profusion at 20° to 38° C., and the latter at 16° to 30° C. Amylase was found to be contained in the spores at any temperature at which they were produced. The same held good with respect to the mycelium, which, as Harter has already shown (*Journ. Agric. Res.*, xx, p. 781, 1921), produced amylase when grown at temperatures ranging from 9° to 40° C., the enzyme being most active when the fungus was grown at 9°, and least at 40°. The available data are not sufficient to justify the conclusion that the amount of amylase contained in the spores is correlated in any way with the temperature at which the organism was grown.

Comparative tests of the hydrolysing power of the spores and mycelium grown at the same temperature have shown that the enzyme of the latter is more active than that of the former when compared on the basis of unit weight.

MATSUMOTO (T.). **Further studies on physiology of Rhizoctonia solani Kuhn.**—*Bull. Imp. Coll. Agric. and Forestry* (Morioka, Japan), v, 63 pp., 1 pl., 8 figs., 1923.

The results of inoculation experiments with various strains of *Rhizoctonia solani* on the leaves of Azuki and broad beans, *Cameria*, sliced potato disks, and cucumber stems have shown that mechanical pressure exerted by the hyphae is an important factor in the penetration of the cuticular layer and cell wall. The latter process, however, appears to be assisted also by the action of enzymes or allied substances liberated by the invading hyphae.

The effect of H-ion concentration varies according to the nature of the media used, and it is, therefore, almost impossible to name a definite optimum P_H value for the growth of the fungus. In no case was mycelial growth secured on any medium having a P_H value of 2·5. As regards the limit of alkalinity the results of the tests were less consistent. Thus on Czapek's solution mycelial growth was fairly luxuriant at P_H 9·8, while in turnip or potato decoction it was scanty even at P_H 8·5. The change of the P_H value due to the growth of the fungus in the culture media is not constant but appears to fluctuate with the different solutions used.

Further experiments were conducted to ascertain the effect of the H-ion concentrations on the activity of the enzymes secreted by the fungus. The amylase of the strain P1 (isolated from an infected potato stem in California, 1917) is active within a range of P_H 3·4 to 9·4, the optimum being about 6·2 or less. A marked acceleration of invertase activity occurs on the acid side, the optimum after twelve hours being observed at the exponent P_H 2·8, and after two days at P_H 3·2. On the alkaline side invertase activity is markedly retarded, the limit appearing to be P_H 9·1. The optimum H-ion concentrations for maltase and emulsin seem to be approximately P_H 6·0 and P_H 5·2 respectively. Gelatine is liquefied by the mycelial extraction when NaOH is added, but not when HCl is used. Liquefaction, however, may take place in the latter case also if the enzymes secreted by the living hyphae are substituted for the mycelial extractions.

When grown on potato the fungus secretes intracellular and extracellular pectinase by means of which it dissolves the middle lamellae of the host plant tissue. The diastatic activity, both intra- and extracellular, of the various strains of *Rhizoctonia* studied, increases in proportion to the mycelial growth, the maximum activity occurring immediately before sclerotial formation. Diastase and invertase are always found in appreciable quantities when the fungus is grown on any of the media studied, the amounts not necessarily being increased when the carbohydrate supplied was starch or sucrose respectively. The fungus secretes maltase in any medium, but the enzyme is produced in large quantities when maltose is present. Maltase is more active in the extracellular than in the intracellular enzymes.

Glycerine can be utilized to a great extent in the presence of peptone, but not in that of ammonium nitrate or sodium nitrate. *Rhizoctonia* thrives on carbohydrate media containing peptone as a source of nitrogen, the rate of its development being proportionate to the amount of peptone used, at least up to 4 per cent.

In glucose media containing 0·1 per cent. NH_4NO_3 the hyphal growth increases in proportion to the degree of the concentration of glucose, provided that the latter does not exceed $\frac{3}{8}M$. [$M.$ = 1 molecular weight in grammes in 1 litre of water], while in solutions containing 0·2 per cent. NH_4NO_3 the best growth is observed on media with a higher concentration of glucose up to $\frac{3}{4}M$. In general, sclerotial formation was more or less checked as the concentration of glucose increased within the limits tested. The hyphal growth of the fungus appears to be somewhat retarded by the addition of even low concentrations of tannin, though a very low concentration stimulated mycelial growth on sucrose-containing media. Tannic acid inhibits the diastatic action of the fungus even at the lowest concentration used. At 0·083 per cent. no hydrolysis of starch was observed. Tannic acid does not appear, however, to affect the action of invertase.

'Staling' phenomena were observed in the cultures of this fungus. The deleterious action of the toxic substances in staled solutions was more marked in some of the author's experiments when the cultures contained the filtrate of the media formerly occupied by a different strain of the fungus. These toxic substances may be deactivated by

heating, and the growth of the fungus is promoted by eliminating them even if no more nutrient is added.

The fusion of hyphae occurs more readily between those of strains isolated from the same species of host than between isolations from different hosts.

In general it can be said that the physiological characteristics of *Rhizoctonia solani* may be more or less modified by environmental conditions, and may also vary with the different hosts on which it occurs.

GARNER (W. W.), MCMURTREY (J. E.), BACON (C. W.), & MOSS (E. G.). **Sand drown, a chlorosis of Tobacco due to magnesium deficiency, and the relation of sulphates and chlorides of potassium to the disease.**—*Journ. Agric. Res.*, xxii, 1, pp. 27–40, 7 pl. (1 col.), 1923.

The principal results of the authors' investigations on sand drown of tobacco have already been noticed [see this *Review*, ii, p. 80]. In the present paper the experimental work on which the conclusions already reported are based is described in considerable detail, especially with regard to the methods of pot culture, which involve certain important modifications of those ordinarily used in the study of fertilizer problems.

GRAM (E.). **On Kartoffelbrok og Foranstaltninger mod denne i vore Nabolande.** [Wart disease of Potatoes and the legislation against it in force in neighbouring countries.]—*Ugeskrift for Landmaend*, lxviii, 3, pp. 32–33, 1923.

Considering the position with regard to wart disease of potatoes (*Chrysophlyctis endobiotica*) [*Synchytrium endobioticum*] in countries adjacent to Denmark, the author thinks that the Danish quarantine legislation [see this *Review*, i, p. 125] was promulgated only just in time. Should the disease once gain a foothold in Denmark, the quarantine regulations of other countries would very considerably reduce the Danish potato exports.

In Germany the disease is greatly on the increase, especially in industrial districts. In the Rhine Provinces there are at least 200 hect. of infected ground, and in Westphalia 250 hect. The disease occurs also in various parts of Saxony, Silesia, Hanover, and Brandenburg. From the Danish point of view, however, the greatest importance attaches to the spread of the disease in Mecklenburg, Hamburg, Lübeck, and Schleswig-Holstein, whence it may very easily be introduced into Denmark by means of small frontier transactions, or by fishermen landing at the ports.

In Holland there are 75 hect. of infected ground, all in the possession of smallholders and the peasantry. Since 1920 the cultivation of resistant varieties on infected soil has been permitted, subject to annual inspection. Potatoes may be imported from Great Britain when accompanied by a certificate of freedom from wart disease, but not from Germany.

In Norway, where the disease is very prevalent in the vicinity of Christianssand, the cultivation of the resistant British varieties, King George, Great Scot, Lochar, and Templar, has been proceeding on a large scale since 1920.

The disease has not been observed in Sweden since 1913, when the only case of infection was promptly suppressed by means of crop rotation and soil disinfection with 1 per cent. formalin. It is possible that the subsequent absence of infection may also be due to the inability of the fungus to withstand the severe northern winters.

CLAUS (E.), KÖCK (G.), & JANCHEN (E.). **Neuere Erfahrungen über den Einfluss von Uspulun und Uspulunbolus auf die Kartoffelerträge.** [Recent experiments on the influence of uspulun and uspulunbolus on Potato production.]—*Oesterr. Zeitschr. für Kartoffelbau*, ii, 8, pp. 29–30, 1923.

The results of previous experiments (*Oesterr. Zeitschr. für Kartoffelbau*, i, 11, pp. 41–42, 1921) showed that the yield from potatoes treated with uspulunbolus before planting considerably exceeded that of the untreated controls. A further series of tests carried out in 1922 both with uspulun and uspulunbolus gave conflicting results, the yield in certain plots being higher, and in others lower, than in the untreated controls. On the whole, the favourable effects predominated, the average increase in the yield being estimated at 25 to 45 per cent. Uspulunbolus not only acts as a stimulant to production but also as a preventive of decay in storage. Further investigations are necessary to determine the correct degree of maturity of the potato at the time of treatment and the meteorological conditions in which the best results may be expected.

Zum Auftreten des Kartoffelkrebses in Böhmen. [The occurrence of wart disease of Potatoes in Bohemia.]—*Wiener landwirtsch. Zeit.*, lxxiii, 1–2, p. 3, 1923.

Wart disease of potatoes [*Synchytrium endobioticum*], which in 1921 was reported from only one locality in the north of Czecho-Slovakia, has been steadily spreading to other districts, and the situation is now regarded as very serious. According to a member of the National Agricultural Council, the entire potato cultivation of Czecho-Slovakia is imperilled unless absolutely immune varieties can be secured for planting. The export of potatoes from the infested districts has been prohibited.

PARAVICINI (E.). **Die Kartoffelkrankheiten in Niederländisch-Ost-Indien.** [Potato diseases in the Dutch East Indies.]—*Centralbl. für Bakt.*, Ab. 2, lviii, 9–12, pp. 212–220, 1923.

Mosaic disease is responsible for very severe damage to the Dutch East Indian potato crops, especially in Western Java and the Tengger mountains, where the amount of infection at a recent inspection was estimated in certain fields at 75 per cent. The average yield per plant was only 65 gm. as compared with 151 gm. from healthy plants.

Leaf roll also causes considerable losses in the Tengger mountains and the Preanger Regency. It does not occur in Central Java or Sumatra.

Early blight (*Alternaria solani*) attacks not only potatoes but various other Solanaceae, e.g. tomato, eggplant, *Solanum wendlandii*, *Cyphomandra betacea*, and *Datura* sp.

Late blight (*Phytophthora infestans*) and bacterial ring disease

(*Bacillus solanacearum*) are of minor importance in the Dutch East Indies. Blackleg [*Bacillus atrosepticus*] and *Rhizoctonia* diseases occur only in isolated cases, and the attacks are negligible in severity and extent. Various species of *Fusarium*, *Verticillium*, and a species of *Rosellinia* frequently destroy the roots of potatoes grown on freshly reclaimed forest land.

Sprain ('Rostfleckenkrankheit') is a tuber disease which cannot be detected externally. Sections of affected tubers, however, reveal irregular, brown spots, very variable in size, number, and position. The spots are never situated in the region of the vascular bundles, nor do they extend to the surface of the tubers. The brown discoloration is due to cork layers surrounding single cells or groups of cells. The starch content undergoes no change, but there are other indications of abnormal chemical processes. Sprain does not occur on tubers under 20 gm. in weight, and sometimes affects only a few tubers on a plant.

Attempts to isolate a causal organism from affected tubers gave negative results, and the disease is believed to be due to chemical disturbances consequent on a deficiency of lime in the soil. Experiments in the control of the disease by liming the soil gave conflicting results. The cultivation of infected potatoes on comparatively healthy soils, however, gave a sound crop in the third generation.

Sprain neither reduces the yield of the crop nor spoils the flavour of the potatoes. Their appearance, however, is much impaired, and they fetch a lower price than healthy ones. The expensive white varieties are more severely attacked than the ordinary yellow ones cultivated in the Dutch East Indies. Certain 'indigenous' varieties, e.g. Kentang Djawa, Colonjo, and Radja Singa, are almost immune from sprain. The last-named variety is quite free from sprain in Central Java, but on being transferred to the Karo Plateau, where the disease is very severe, 2·4 per cent. of the tubers became infected. Besides the Karo Plateau, where potato cultivation has been almost brought to a standstill owing to the ravages of sprain, the disease is also very severe in the Tengger mountains and Poetjon (Eastern Java). In the Preanger Regency it has been declining in severity for some years. It occurs more extensively in comparatively low-lying situations than at high altitudes.

Actinomyces scab (*A. scabies*) is of widespread occurrence, and is steadily increasing on the yellow varieties. Its economic importance, however, like that of the dry rot caused by different species of *Fusarium*, is negligible in the Dutch East Indies.

Lasiodiplodia [*Diplodia*] *tubericola* has been found on potatoes exported from Java to America, and the mycelium of *Phytophthora erythroseptica* on potatoes which had rotted in transit from Java to Holland. Neither fungus has previously been known to occur in Java.

BISBY (G. R.). **Manitoba Potato diseases and their control.**—*Manitoba Farmers' Library Extension Bull.* 66, 19 pp., 10 figs., 1923.

A brief account in popular language is given of the causes,

symptoms, and effects of the principal fungous and physiological diseases of potatoes in Manitoba, together with appropriate measures for their control. Leaf roll and mosaic are stated to be the most serious diseases occurring at present in the province. Dry stem rot and black scurf (*Rhizoctonia solani*), blackleg (*Bacillus atrosepticus*), wilt (*Fusarium oxysporum*), and dry rot (*F. discolor sulphureum* and other species of *Fusarium*) also cause severe losses. Late blight (*Phytophthora infestans*), powdery scab (*Spongospora subterranea*), and wart disease (*Synchytrium endobioticum*) are not known to occur in Manitoba.

There is at present no potato variety on the market which is resistant to the above diseases occurring in Manitoba, but growers are advised to cultivate exclusively healthy seed of the following standard varieties: Early Ohio, Beauty of Hebron, Irish Cobbler, and Green Mountain.

FRANCHINI (G.). **Essais d'inoculation de latex parasitisé aux souris blanches. Abcès du foie expérimentaux déterminés par les amibes des latex.** [Inoculation experiments with parasitized latex on white mice. Abscesses of the liver produced experimentally by latex amoebae.]—*Bull. Soc. Path. exot.*, xvi, 3, pp. 162–166, 1 fig., 1923.

It was shown in a previous paper [see this *Review*, ii, 5, p. 229] that the inoculation of white mice with the parasitized latex of various species of *Euphorbia* resulted in slight infection. The present paper describes in detail the technique and results of a further series of experiments on nine white mice. In two cases (one of peritoneal inoculation and the other of ingestion of a culture from the spleen of a mouse inoculated with latex from *E. antiquorum*), a post-mortem examination revealed hypertrophy and abscess of the liver. In both cases amoebae were found in abundance, especially near the edges of the abscess and in the digestive tract, and phagocytosis of the red corpuscles took place on a large scale. Cultures of the amoebae on Nöller's medium resulted in the production of the forms previously described.

In the seven remaining mice of the series the effects of inoculation with, or ingestion of, the latex of various species of *Euphorbia* and *Urtica* were less pronounced, while a post-mortem examination of six others similarly treated gave negative results.

FRANCHINI (G.). **Action du latex d'Euphorbes sur différents trypanosomes. Culture de flagellés dans des latex divers.** [The action of the latex of *Euphorbiae* on various trypanosomes.]—*Bull. Soc. Path. exot.*, xvi, 1, pp. 41–50, 1923.

Experiments are described in some detail which show that various species of *Trypanosoma* (*T. lewisi*, *T. gambiense*, *T. brucei*, &c.), as well as the organism of oriental sore [*Leishmania tropica*] and some species of *Herpetomonas* from animals, can live for a considerable time in latex, and in some cases multiplied freely in latex cultures.

SHARPLES (A.) & LAMBOURNE (L.). **Preliminary report on brown bast experiments in Malaya.**—*Malayan Agric. Journ.*, xi, 2, pp. 30–36, 1923.

The results of the first series of field experiments on the production of brown bast in Malaya indicated that the systems of tapping rubber trees in common use were not sufficiently drastic for the purposes of comparative tests, a single daily cut on a quarter or half the tree not producing enough brown bast to lead to any definite conclusions. Experiments with spiral cuts were accordingly undertaken. After seven months the incidence of brown bast in the plots tapped on the full spiral system every third day was only 5 per cent. as compared with 10 per cent. in the plots tapped on alternate days, and 20 per cent. in those tapped daily. An extension of the interval between successive tappings is therefore clearly shown to be advisable [see this *Review*, ii, pp. 232 and 396].

The total yield from trees tapped on a half spiral every third day during seven months was higher than would be expected on a proportional basis when compared with the yields from those tapped daily or every other day. This point is of considerable importance in relation to the brown bast problem, many investigators being agreed that the disease is a wound response due to over-tapping. The results of these experiments indicate the possibility of yields being limited by the development of a high percentage of brown bast. In the writer's opinion the yield is sharply limited according to the type of soil and general growth conditions. Below this limit the amount of brown bast developed is of little practical importance, but above it there is so great an increase in the disease as to counteract the augmented yield. This point must be considered in the general question of obtaining high-yielding strains of *Hevea brasiliensis* by bud-grafting and selection.

It was found during the course of the experiments that in order to obtain a guiding line as to the behaviour of different plots with reference to brown bast development, at least three months previous heavy tapping was necessary. A second series of experiments confirmed the previous observation of a sudden rise in the incidence of brown bast during certain months, followed by a long period of quiescence. In 1919, and again in 1921, March to August was a quiescent period; in 1922, however, May, June, and July were heavy brown bast months. Hence there is some difficulty in correlating the incidence of brown bast with meteorological conditions or other external factors. Another interesting feature in this series of experiments was the cessation of the extension of brown bast at definite points marked by the different ages of the tapped bark. Out of 410 trees tapped in virgin bark above the 36 inch level, 133 developed the disease. In 40 of these no extension took place after tapping was stopped; in another 20 the brown bast was checked at the 36 inches mark, which indicated the junction between the virgin and the youngest renewed bark of previous cuts; in 47 trees the brown bast extended to the 24 inches mark, which indicated the junction between the old and young renewed bark, and in 19 the affection extended to the base of the tree.

In one plot of 44 trees tapped on a seven-eighths spiral the response to tapping was obviously abnormal. From November

1920 to August 1921 only two cases of brown bast were reported, followed in September 1921 by a sudden increase of six diseased trees. From that time until December 1922 the plot developed the normal heavy incidence of the disease found on severely tapped trees, and this was correlated with a sudden increase in the average tree yield. The conclusion must be drawn that brown bast is closely associated with high yields, and that it will act as a limiting factor in high production.

In numerous cases the appearance of the brown bast symptoms is so sudden that it may be classed with the phenomena dependent on 'trigger action', i. e., a sudden release followed by immediate effects. The typical symptoms of brown bast frequently appear in twenty-four hours on trees which seemed perfectly normal the day before. It appears highly probable that brown bast is due to a process of exhaustion.

The recently described breaking-down of the sieve-tubes which has been regarded as an incipient stage of brown bast [see this *Review*, i, p. 144], and included under the term phloem-necrosis, is characterized in other cases of phloem-necrosis by lignification of the cellulose walls of the sieve-tubes. The latter phenomenon, however, frequently accompanies tapping, even in trees which cannot be suspected of brown bast. Pending further inquiry, therefore, the relation of this condition to the disease cannot be regarded as established.

Attention is drawn to the risks attendant on the system of bud-grafting from high-yielding trees which is now widely practised in Malaya. High yielders are known to succumb to exhaustion earlier than trees with an average production, and one of the results of bud-grafting already observed is an insufficient development of leaf cuticle, which facilitates attack by various species of fungi, which are normally saprophytic. At present there is a very dangerous alga, *Cephaleuros mycoidea*, epiphytic on rubber leaves, which causes serious damage to tea, cloves, and pepper [see this *Review*, ii, p. 337], and would certainly injure *Hevea* if it succeeded in penetrating the thin cuticle of the bud-grafts. The authors think that the bud-grafting results are not sufficiently encouraging to form the basis of a definite policy, especially in view of the great risks attaching to the system.

SHARPLES (A.). **Final report on treatment of mouldy rot disease with agrisol.**—*Malayan Agric. Journ.*, xi, 2, pp. 36–37, 1923.

For eighteen months the rubber trees on an estate infested by mouldy rot (*Sphaeronema fimbriatum*) have been treated with agrisol [see this *Review*, i, p. 329]. While total eradication of the disease appears to be impossible, very effective control has been secured at the remarkably low cost of 10½ cents [about threepence] per acre per month. The macrospores of *S. fimbriatum*, unlike the spores of the *Phytophthora* of black stripe canker, are resistant to desiccation, and a recurrence of the attack under suitable conditions is therefore probable after dry weather has caused its temporary disappearance. The number of affected individuals, however, may be reduced to a minimum by the routine application of agrisol on the lines previously recommended.

EDWARDES (J.). **Mould prevention tests with sodium silico-fluoride.**—*Bull. Rubber Growers' Assoc.*, v, 1, pp. 21–24, 1923.

The promising results previously obtained by Dr. Stevens in the prevention of mould on sheet rubber with sodium silico-fluoride have already been described [see this *Review*, i, p. 263, and ii, p. 139]. Further tests showed that the solution was effective as a fungicide at a concentration of 0·25 per cent., the minimum quantity necessary for coagulation being 1·5 gm. to 3,000 cc. standard latex. Two series of samples were therefore tested to determine the effect of soaking sheet rubber in solutions of the chemical of different strengths: (*a*) S. S. F. sheet soaked for two hours after smoking in sodium silico-fluoride solution; and (*b*) S. S. F. sheet soaked for thirty minutes before smoking in sodium silico-fluoride solution. The advantage of soaking the sheet before smoking was most marked, producing resistance to mould under very favourable conditions for twenty-two days in the case of the saturated solution. The rubber treated with the higher percentage solutions did not absorb moisture as readily as the controls which quickly developed an opaque strip in the interior, causing the effect usually termed by the brokers 'undercured'.

Further tests in which both acetic acid sheet and sheet coagulated with sodium silico-fluoride were exposed to heavy rains for periods of two hours and an entire night respectively, showed that resistance to mould was greatly increased by the use of sodium silico-fluoride. The extreme liability of acetic acid sheet to mould was strikingly illustrated in these tests.

MIZUSAWA (Y.). **A bacterial rot disease of Saffrons.**—*Ann. Phytopath. Soc. Japan*, i, 5, pp. 1–12, 1923.

Bacterial rot of the saffron crocus [*Crocus sativus*] was first observed in Japan in 1909, but attracted no special attention till 1917, since when its severity and distribution have considerably increased.

The first symptoms of the disease become noticeable in December, when the leaves lose vigour, wither, and gradually turn yellow. The roots and corms are found to be dark brown. This is the common form of the disease which results from successive culture in infected fields. In the rare cases when diseased corms are planted in healthy fields infection occurs at some point of the sheath, followed immediately by yellowing of the leaves.

The causal organism, a peritrichiate bacterium, to which the name *Bacillus croci* n. sp. is given, was repeatedly isolated from decayed corms and sheaths. It resembles, but is not identical with, *Bacillus carotovorus*, *B. omnivorus*, *B. oleraceae*, and *B. aroideae*. It is a medium sized rod, with rounded ends, 1·2 to 3·2 by 0·6 to 1·1 μ, usually single but occasionally in pairs or short chains. Endospores and capsules not seen. Flagella two to four. Gram negative. It grows readily on various media, especially with the addition of sugar, producing white, round colonies. On carbohydrate media the organism produces acid but no gas. The optimum temperature for development is 25° to 28° C., the maximum 40° C., the minimum below 10° C., and the thermal death point 55° C. The results of experiments showed that the organism can

tolerate a high degree of acidity. It retains its virulence for a period of ten to twelve months. The morphological and physiological characters are fully described. Healthy corms inoculated with pure cultures of the organism rapidly exhibited the typical symptoms of the disease. *Bacillus croci* remains on the decayed part of the plant and in the infected soil. The disease is disseminated mainly by transplanting infected corms. The group number is 221.2233032.

The selection of healthy corms and disinfection of seed corms in saturated lime water for half an hour are recommended.

Disease defeated by drainage.—*South African Sugar Journ.*, vii, 2, p. 179, 1923.

Prof. Cobb, entomologist to the Cairns (Queensland) Sugar Bureau, in the course of a report on gummosis (*Bacillus vasculorum*) of the H. Q. 426 variety of sugar-cane, states that the chief factors responsible for the disease are: (1) poor drainage; (2) an impervious subsoil within two or three feet from the surface; (3) defective cultural methods; and (4) abundant rainfall. Rotation of crops is recommended on land which has long been under susceptible varieties of cane.

An example of the benefit derived from proper drainage was brought to Prof. Cobb's notice at Halifax [Queensland], where a sixty-acre plantation on the river bank is intersected by a road. On the side adjoining the river good crops of sugar-cane have always been obtained, while the cane grown on the other portion, which is bounded on the far side by a swamp, has invariably been a failure. By cutting a few deep main drains through the block emptying on to the swampy land, and running cross drains into them, the present owner has succeeded in raising a fine crop of cane.

CLAYTON (E. E.). **The relation of temperature to the Fusarium wilt of the Tomato.**—*Amer. Journ. of Bot.*, x, 2, pp. 71–87, 4 pl., 1 fig., 1923.

There are three different tomato diseases in the United States, supposed to be caused by three distinct species of *Fusarium*. They are the 'summer blight' of California, the 'yellow blight' of the Pacific North-west, and '*Fusarium* wilt', the last-named being one of the most serious tomato diseases in the southern States. For this disease, which is due to *F. lycopersici*, the author has determined definite temperature limits under greenhouse conditions in Wisconsin soil-temperature tanks. The behaviour of the fungus was tested by incubating pure cultures of a strain of the fungus from Indiana at each of twelve graduated temperatures ranging from 4° to 38° C. It was found that the minimum for growth was 9° to 10° C., the optimum about 28° C., and the maximum 37° C. Under greenhouse conditions the soil temperature range most favourable to the development of the susceptible commercial tomato varieties, Mangus and Chalk's Early Jewel, was 24° to 31° C., a range which, therefore, includes the optimum temperature for the development of *F. lycopersici*. Growth was still vigorous at 33°.

but was checked at 35°, while it decreased gradually from 24° to below 19° C.

The symptoms of the disease vary in relation to the soil temperature in which the host plant is grown. There is an optimum soil temperature for the disease between 25° and 31° C., characterized by a sudden wilting, usually without yellowing, first of the lower leaves and then of those higher up. At temperatures immediately above or below the optimum, namely 33° C., or 20° to 24° C., wilting is accompanied, and often preceded, by yellowing of the leaves. The appearance of the plants suggests a slow blight rather than wilt, and they are often stunted. At temperatures above 34° or below 20° C. there is no external evidence of the disease. Under certain temperature conditions the fungus may penetrate only into the bundles in the lower portion of the stem; this is often the result of a brief exposure to temperatures favouring the disease, followed by a fall in temperature sufficient to check the further development of the fungus.

It is reasonable to expect that changes in temperature would not equally increase or decrease both the attacking power of the fungus and the resistance of the host. The correlation between the temperature ranges of the host, the parasite, and the disease, considered separately, is closer in this case than usual in similar diseases. It is especially marked at the optimum points, which are approximately equal for both host and fungus, as well as for the disease caused by the interaction of the two. On the other hand, the disease develops more rapidly at 31° than at 25°, though the fungus grows at least equally well at the latter as at the former temperature. So also the growth of the fungus at 33° to 34° C., the upper limit for the disease, was much less vigorous than at 19° to 21° C., the lowest temperature at which the disease occurs. Both host and parasite can develop at a wider range of temperature than the disease, the latter being absent above 34° or below 20°, though both are within the growth range of the tomato and of the *Fusarium*.

In two of the experiments both air and soil temperatures were controlled. The air in three greenhouse compartments was maintained at temperatures of 17°, 27°, and 33° C. respectively. Three different soil temperatures were maintained in each of these compartments, namely, 17°, 27°, and 35° C. Air temperature was found to be as effective as that of the soil in controlling the appearance of the disease, which developed fatally in only two of the nine combinations of air and soil temperatures, namely, warm air (27° C.) and warm soil (27° C.), and hot air (33° C.) and warm soil (27° C.). At a cool air temperature (17° C.) and optimum soil temperature for the disease (27° C.), heavy infection occurred in the root and extended up into the basal portion of the stem, but there were no external symptoms of the disease. The temperature conditions of soil and air most favourable to the disease are 27° C. and 28° C. respectively, with short interludes of sudden rises in air temperature to 33° or 34° C.

The evidence accumulated during the course of these experiments indicates that the wilting and death of plants attacked by *F. lycopersici* is due to toxic action rather than to a mechanical plugging of the xylem bundles.

TAYLOR (W. H.). **Tomato diseases. Black-stripe and its control.** —*New Zealand Journ. of Agric.*, xxvi, 2, pp. 101–103, 1923.

A serious outbreak of blackstripe disease of tomatoes (? *Bacillus lathyri*) was recently investigated in the Hutt Valley, Wellington, New Zealand. A comparison of the diseased plots with adjacent healthy fields indicated that the epidemic was promoted by the application of excessive quantities of stable manure, and that the injurious effects of the latter can be counteracted by an additional dressing of blood-and-bone and sulphate of potash, this being attributed to the action of potash, which stiffens the tissues of the plant and also improves the quality of the fruit. The results of recent experiments in Canada are stated to show that the disease can not only be prevented, but actually cured by fertilizing the plants with acid phosphate or bone-flour (3 oz. per plant) and potassium sulphate (½ oz. per plant) either before transplanting or just as the blooms appear; while in England watering with sulphate of potash solution or dressing with the solid compound is reported to enable the infected plants to grow away clean when attacked by *B. lathyri*.

DE KONING (M.). **Een nieuw bestrijdingsmiddel tegen de wortelzwam.** [A new measure for the control of the root fungus.]— *Tijdschr. over Plantenziekten*, xxix, 1, pp. 1–4, 1923.

All attempts to eradicate the 'root fungus' (*Trametes radiciperda*) [*Fomes annosus*] from Dutch pinewoods have failed, including the method of separating the diseased from the healthy trees by means of trenches.

In September 1922, the Dutch Heathland Association made an excursion to Bremen, where a system of so-called 'forest rejuvenation', which the author thinks would be of service in Holland in connexion with this disease, was seen. As soon as the trees show signs of deterioration, felling is carried out on a large scale, all the less valuable timber being cut down to provide light and air for new seedlings. Then the 'humus layer' of moss and needles is removed as far as the soil in strips about 2 m. broad, and placed on the intervening strips, which are about 1 m. broad. The bare patches are then sown with a mixture of beech, silver fir, larch, birch, oak, *Sorbus*, and *Prunus*. This procedure serves the double purpose of providing a good humus layer and of keeping the root fungus in check, the latter rarely occurring in mixed plantations.

RICHARDSON (A. D.). **Witches' Broom on Silver Fir.**—*Gard. Chron.*, lxxiii, p. 11, 1 fig., 1923.

'Witches' brooms', the popular name for the globose swellings caused by *Peridermium elatinum*, are very common on silver firs (*Abies pectinata*) in Ireland and the western parts of Great Britain, where these trees are more extensively grown than in the east of the country. The stems of affected trees are considerably weakened, and liable to break under wind pressure, and the value of the timber is much depreciated.

The first symptom of infection is a small swelling, which keeps pace with the growth of the affected branch or stem. Erect shoots are often produced from such swellings, giving the characteristic 'broom' appearance. The leaves arising from affected shoots are

short, pale, and of annual duration only, defoliation occurring in the autumn. The aecidia are produced on the under side of the leaves. The bark is ruptured and cast off at the cankered swellings.

P. elatinum is the aecidial stage of the heteroecious fungus *Melampsorella caryophyllacearum*, the uredo and teleuto stages being produced on the stems and leaves of *Stellaria*, *Arenaria*, *Cerastium*, and other Caryophyllaceae.

The disease is prevalent on the Continent, and has also been found on *Abies nordmanniana*, *A. cephalonica*, *A. pinsapo*, *A. balsamea*, and *A. sibirica*.

VALCKENIER-SURINGAR (J.). **Eine Ulmenkrankheit in Holland.** [An Elm disease in Holland.]—*Mitt. deutsch. dendrol. Gesellsch.*, xxxii, pp. 145–147, 1 fig., 1922.

After a brief recapitulation of the symptoms of the obscure disease of elms occurring in Holland and the north of France [see this *Review*, i, pp. 277, 334, and ii, pp. 1, 92], the author questions the accuracy of the conclusions reached by Miss Schwarz as to the identity of the causal agent. The fact that the *Graphium* isolated from diseased elms produced a brown discoloration (but not the other typical symptoms of infection) when inoculated into healthy trees is not a convincing proof of pathogenicity. Several fungi are known to produce similar discolorations on elms and other trees, and in the absence of further proof of its causal relationship to the disease the author is unable to accept Miss Schwarz's conclusions. He also regards her description of the fungus as a new species of *Graphium ulmi* as requiring further confirmation.

DUFRÉNOY (J.). **Biologie de l'Armillaria mellea.** [Biology of *Armillaria mellea*.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 277–281, 2 figs., 1922.

In the Pyrenees, and particularly above Barèges, *Armillaria mellea* is responsible for the destruction of the birch, and in the Landes region it is, in common with *Trametes pini*, and to some extent *Rhizina undulata*, amongst the principal cryptogamic enemies of *Pinus maritima*. On the outskirts of the latter region, cork oaks whose roots are attacked by *Heterodera radicicola* are reported to be killed by the same fungus. Other workers have recorded it seriously injuring fruit trees in Lot-et-Garonne and elsewhere. Although possibly able to attack vigorous trees, the fungus appears to act usually as a secondary parasite under circumstances which are still not clearly defined. Chestnuts suffering from ink disease may be attacked by *A. mellea*, while young chestnuts planted too deeply are very liable to be killed by this form of root rot, as the mycelium first attacks the asphyxiated roots, then the underground region of the collar, and may finally ascend in the cambium of the trunk to a distance of several metres above soil level.

The extended use of resistant varieties, which may be employed as stocks in certain cases as, for instance, in growing walnuts, is recommended.

GREENWOOD (F. W.). **Collar-rot in Pea crops on the Wairau plain.** —*New Zealand Journ. of Agric.*, xxvi, 1, pp. 35–37, 1 fig., 1923.

Serious damage to pea crops in the Wairau Plain, Marlborough, New Zealand, is reported. The disease, which is caused by a species of *Fusarium*, first appears in the stem just above the collar, subsequently spreading to the roots, which are reduced to a putrid mass. Extension upward along the stem also occurs. Infection is carried on the seed and straw, rarely through the soil.

The worst attacks occurred on badly drained and sour soils, and also on very sandy soils in which nitrogen was deficient. The application of lime is recommended.

NEWHALL (A. G.). **Seed transmission of Lettuce mosaic.**—*Phytopath.*, xiii, 2, pp. 104–106, 1923.

Lettuce mosaic is usually present to the extent of 3 to 6 per cent. in western New York, but was very prevalent in 1921, its spread being correlated with a general infestation of aphids. Milkweed (*Asclepias syriaca*) and water dock (*Rumex britannica*) were tried as overwintering hosts, but inoculations were negative. In order to test the possibility of seed transmission, seed was harvested from twelve diseased plants and sown. The seed from three of these plants yielded twenty-seven mosaic seedlings out of 563 grown, whilst that from the remaining nine, grown in sterilized soil under very carefully controlled conditions, gave fifty-one mosaic plants out of 1,465. These results were supported by field observations, and both seem to prove that mosaic of lettuce is frequently transmitted through the seed.

GLEISBERG (W.). **Plasmodiophora brassicae Woron.: Zur Auswertung von Kruziferen-Infektionsreihen.** [*Plasmodiophora brassicae* Woron: On the evaluation of infection tests with Cruciferae.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, iii, 2, pp. 10–12, 1922.

In order to test the susceptibility of a number of Cruciferae to club-root (*Plasmodiophora brassicae*), ninety-three plants belonging to the sub-families Siliquosae, Siliculosae, and Nucamentaceae were sown in heavily infested plots in 1922. Only fifty-two of the species germinated, among which the incidence of infection is given in detail. There was complete absence, or barely a trace, of infection in the Arabideae (except *Cheiranthus allionii*, 20 per cent.), several of the Sisymbriae, Alysseae, Lepidieae, *Brassica napus* and *B. rapa*; 70 to 100 per cent. of infection in *B. cernua*, *B. juncea*, *Sinapis alba*, and various Alysseae, Camelineae, and Thlapseae. The remainder were intermediate. An adjacent plot of white cabbage showed 100 per cent. of infection, while the wild form of *B. oleracea* had only 16·6 per cent. The immunity of *B. rapa* and *B. napus* conflicts with Sorauer's statement that all cultivated forms belonging to these two species are susceptible to the disease.

IMPERIAL BUREAU OF MYCOLOGY

REVIEW

OF

APPLIED MYCOLOGY

VOL. II OCTOBER 1923

BEACH (W. S.). **A crown rot of Rhubarb caused by Phytophthora cactorum.**—*Pennsylvania Agric. Exper. Stat. Bull.* 174, 28 pp., 5 pl., 1922.

In a short introduction the author states that the *Phytophthora* crown rot of rhubarb in Pennsylvania, to which he called attention in a previous report [see this *Review*, i, p. 102] is caused by *Phytophthora cactorum* (Leb. & Cohn) Schroet., heretofore known in America mainly as causing a disease of ginseng and a rot of apples and pears. As some experimental results indicate that the fungus from ginseng or apple may pass over to rhubarb, the crown rot of the latter will probably be found to have as wide a range of distribution as the other two diseases. Near Philadelphia, where rhubarb is fairly extensively grown, a number of fields have had to be abandoned owing to the disease. The heaviest losses usually occur in new plantings, the general practice of dividing old crowns for setting new hills apparently facilitating the entry of the parasite through the wound surfaces, the principal source of infection appearing to be the diseased plants in the original field. In a typical case cited by the author, a field was set in the spring with setts taken from a place where there was a mild degree of infection. By the end of September only 46·1 per cent. of the hills had healthy and vigorous plants, while 34·2 per cent. had been completely destroyed; 9 per cent. were still alive but showed typical symptoms of attack, and 10·7 per cent. were weakly and probably diseased. Plants attacked late in the season may recover sufficiently to become more or less productive the next year, but it is probable that they are the leading source of future infection. In older fields the plants are killed comparatively slowly; those that survive the setting-out season in a vigorous condition appear better able to withstand further attacks.

The first outward symptom of the disease, which usually appears during July, is the wilting of one or of a few leaf blades, followed

by a loss of turgidity in the leaf stalk, so that the whole leaf structure falls prone on the soil. In warm, muggy weather the symptoms, which may appear in leaves of any age, are rapid in development and spread to other leaves, the whole plant being killed in a few days. In some cases, however, only a section of the crown is killed, the rest of the plant appearing healthy until another rainy period revives the activity of the fungus. In plants in an advanced stage of wilt, an extensive brownish-black discoloration marks the area occupied by the mycelium, while brown, depressed lesions develop on the surface of the portions of the leaf stalks enveloped in the crown. All the rotted tissues contain the mycelium, at first intercellular but later penetrating the cells. The fungus usually does not advance far into the petioles; a prolonged rainy period occasionally renders possible the infection of young leaf blades or the upper parts of the petioles, but ordinarily the aerial parts wilt and collapse as a consequence of the destruction of the crown and roots. The tissues invaded by the *Phytophthora* are at first not much softer in texture than healthy ones, but secondary saprophytes soon bring about the complete disintegration of the affected parts.

It seems probable that a sufficiently prolonged drought may preclude the development of the crown rot in any season, yet the disease has been evident to some degree in the vicinity of Philadelphia each year from 1918 to 1921; the damage was greatest in 1920 and least in 1918, the former summer being very wet and the latter very dry during the critical time for the development of the disease. No difficulty was met in securing infection in April both on roots and petioles of rhubarb in frames. It is probable that the fungus becomes established much earlier than indicated by the first outward symptoms. According to field observations, the disease is able to assume severe proportions on well drained soil, although heavier losses occur on low, wet areas. The physical character of the soil seems to have no influence, except as it tends to increase the water-holding capacity. A rich, fertile soil appears, however, to increase the resistance of the host to the fungus.

Inoculation experiments with *Phytophthora cactorum* from rhubarb gave positive and usually fatal results in practically all instances in which the cultures were inserted in wounds. A small proportion of inoculations without wounding succeeded, but only under very favourable conditions of temperature and moisture. Infection failed in an experiment in which macerated cultures were worked into the soil around the roots of twenty seedlings in pots, care being taken not to wound the roots. Taking into consideration the apparent relation of wounding to the severity of crown rot in the field, it would appear that the fungus is but little able to infect through perfectly sound roots; but though both observations in nature and the general results of the infection experiments indicate that wounding is a very important factor in the spread of the disease, some experiments have shown that infection can take place through the uninjured epidermis under favourable conditions. In culture the maximum temperature for growth was 33° C., the optimum near 25° C., and growth was still possible from 7° to 9° C.

Oospore production was heavier below 20° C. than above, the reverse being the case as regards conidia.

It seems probable that, as in the case of the ginseng disease, the conidia are distributed by wind and by rain. There are also indications that oospores lying in decaying tissues are carried along the rows by cultivation. The writer records cases where the disease was introduced into new fields through oospores and possibly latent mycelium present in the roots.

Oospores were only twice found by the author upon rhubarb material, but were freely produced in culture. Conidia are always produced during damp weather on the petiole lesions above the soil. Comparative tables of measurements of the spores from different hosts are given in support of the conclusion that the fungus described is *Phytophthora cactorum*. This morphological agreement is confirmed by the fact that the form from apple is capable of infecting rhubarb and causes crown rot, although it is somewhat less virulent than the rhubarb isolations. *P. fagi*, as known in Europe, is thought to be at least biologically distinct.

For the control of the disease, the planting of setts from infected stock should be avoided, and new plantings with stock started from seed under disease-free conditions or from a healthy field should be made on soil on which rhubarb has not been grown for a considerable number of years. The destruction of infected plants early in the season and the disinfection of dormant roots before planting are strongly recommended. Bordeaux mixture sprayed into the crowns and over the petioles promises to be effective in preventing the spread of the disease in summer, but will not prevent the decay of plants already attacked.

Mention is made of two other *Phytophthora* diseases of rhubarb in the United States, the outward symptoms of which are similar to those described above. One of these, caused by *P. parasitica* var. *rhei*, is being described by Godfrey under the name 'foot rot' [see following abstract]. In this case, besides morphological differences from *P. cactorum*, the causal fungus appears to be adapted to higher temperatures, but although the disease caused by it progresses somewhat more rapidly during hot weather, there appears to be little difference in the ultimate damage done by the two parasites. The other, also a serious foot rot, occurs in southern Illinois, and is recorded in this paper for the first time. It is caused by a third species of *Phytophthora*, the identity of which has not yet been established.

GODFREY (G. H.). **A Phytophthora foot rot of Rhubarb.**—*Journ. Agric. Res.*, xxiii, 1, 26 pp., 12 pl., 3 figs., 1923.

The present paper is the first record of a serious foot and root rot of rhubarb caused by *Phytophthora parasitica* var. *rhei*. It has been found in Maryland, the District of Columbia and Virginia, but is probably much more widely distributed. In outward symptoms, final damage done, and weather relations, the disease closely resembles the crown rot in Pennsylvania described by Beach [see above abstract].

The fungus was isolated and grown on various culture media, the morphological and cultural characters being briefly described. It

readily infects rhubarb plants, with or without wounding, causing the typical symptoms of the disease and usually killing the plants.

Inoculations on other hosts showed that the fungus was able to rot apples, and readily attacked parsnips and carrots, causing a soft wet rot which, in the latter case, spread to the growing leaves. Turnips were slowly decayed without softening, and in sweet potatoes the rot caused was also firm and dry. On ordinary potatoes the symptoms resembled those caused by *P. erythroseptica*. Green and ripe tomatoes were rapidly attacked, but inoculations on young tomato plants failed. *Colocasia* was immune, and onion practically so. On *Ricinus communis* the young inflorescences and leaves were successfully infected, but the attack was confined to small spots and did not spread.

There is a full discussion of the taxonomy of the fungus, which is regarded as being morphologically similar to *P. parasitica*, except in the size of the oospores, which average about 25 μ in the rhubarb fungus as against 18·6 μ in *P. parasitica*. Other differences from this species are the divergent results obtained on inoculating various other hosts such as tomatoes, and some variations in ability to grow on certain media. These differences are not regarded at present as of more than varietal significance, and the new variety *rhei* of *P. parasitica* Dastur is proposed. *P. melongenae* Sawada and *P. terrestris* Sherb. are also regarded as belonging to the same series and not as distinct species. A detailed English diagnosis of the variety *rhei* is given.

Preliminary experiments indicate that spraying with Bordeaux mixture, during the usually brief period when infection is likely to occur, gives promise of successful control. The other measures recommended are essentially the same as for the disease caused by *P. cactorum* described above.

HOWITT (J. E.). **Two diseases new to Ontario.**—*Scient. Agric.*, iii, 5, p. 189, 1923.

During the summer of 1922 the author's attention was drawn to two diseases, apparently new to Ontario, of considerable economic importance, namely pink root of onions, caused by *Fusarium malli* [see this *Review*, i, p. 405], and white rot of grapes due to *Coniothyrium diplodiella* [see this *Review*, ii, p. 45].

Diseased onions from a marsh bordering on Pelee Point were found to be attacked by *F. malli*, which is prevalent in the onion-growing marshes south-east of Leamington, Ontario. In 1922 at least fifty acres were affected. Outside the Bermuda onion-growing regions of Southern Texas, the economic importance of this disease has not yet been generally recognized, and it requires immediate attention.

White rot of grapes was first observed by the writer in a vineyard near Winona, Ontario. Observations in the Niagara district in 1922 indicated that the disease may cause serious damage to certain commercial varieties, especially Agawam (Roggers No. 15). Over 80 per cent. of the bunches in unsprayed rows of this variety were unmarketable. The disease, which must not be confused with the somewhat similar black rot caused by *Guignardia bidwellii*, may be controlled by spraying with Bordeaux mixture.

MOREAU (L.) & VINET (E.). **Contribution à l'étude de l'apoplexie de la Vigne et de son traitement.** [Contribution to the study of apoplexy of the Vine and its treatment.]—*Comptes Rendus Acad. Agric. de France*, ix, 1, pp. 32–36, 1923.

For the last three years the authors have set aside for the investigation of apoplexy 1·5 hect. of their experimental vineyard containing 6,750 vines at Belle-Beille [Angers, Maine-et-Loire]. It was found that the disease, hitherto believed to be peculiar to the south, was equally virulent in the west of France. In 1920 the number of vines killed per 1,000 was 35, in 1921, 10, and in 1922, 65. Examination of dead vines in the vineyard showed that in 1920, 90 per cent. and in 1922, 80 per cent. were attacked by the parasite responsible for the 'esca' disease [*Fomes igniarius*: see this *Review*, i, p. 416].

The development of the disease is very gradual, the final phase often setting in quite unexpectedly when the internal damage reaches a point at which the tissues are no longer able to convey enough water to meet losses through transpiration. Sometimes, however, a progressive withering of the leaves and tendrils may indicate the approaching death of a branch. In some cases partially defoliated branches form new shoots in July or August, the reduction of evaporation consequent on the loss of leaves being sufficient to preserve the vitality of the buds and enable them to sprout.

The symptoms of the disease may be traced from year to year in a gradual chlorosis, in the failure of the wood to mature properly, and in the withering of individual branches. An examination of the interior of the diseased vines almost always reveals the presence of the tinder-like decay characteristic of the 'esca' disease. Death most often occurs towards the end of the season, the majority of the fatal cases observed being between 15th September and 26th October.

Experiments in the control of the disease by the application to the vines, a few days after pruning, of a solution of arsenite of soda containing 1,350 gm. of arsenious acid per hectol. of water gave excellent results, the number of branches affected during the following season being greatly reduced. By the 26th October the treated plots had an average of 4 dead and 3 partially dead plants, while the controls had 65 dead and 71 partially dead.

The tests will be continued to ascertain whether it is sufficient to treat the vines two consecutive years out of every four, the practice followed in the south.

BRERETON (W. LE G.) & HAMBLIN (C. O.). **Black spot of the Vine (*Gloeosporium ampelophagum*): Experiments with controls 1920–21.**—*Agric. Gaz. New South Wales*, xxxiii, 6, pp. 432–436, 3 figs., 1922.

Experiments were carried out at Hawkesbury Agricultural College and at Yanco Experiment Farm in New South Wales in treating vine anthracnose (*Gloeosporium ampelophagum*) to determine the best winter swabs and sprays, to test summer control sprays, and to test late season sprays for ripening fruit. The first series was inconclusive, as very little disease appeared during the year, but it was found

that the application of a swab consisting of 5 lb. sulphate of iron, one gallon of water, and half a pint of sulphuric acid, delayed the bursting of the young buds about ten days. At Yanco a similar delay in the bursting of the buds was caused by the application of sulphuric acid (1 : 10) swabs. When applied to vines with the buds already burst, the swabbing caused the foliage to be burnt off. Spraying experiments in the winter with Bordeaux mixture (6–4–22), Burgundy mixture (4–6–22), and lime-sulphur (winter strength) had no retarding effect. Owing to the late appearance of the disease, neither swabbing nor winter spraying had any controlling effect.

The following treatment for vine anthracnose is recommended. (1) After pruning, all cuttings should be collected and burnt. (2) If time and labour permit, the loose old bark may be removed, and it must then be burnt. (3) While dormant, the following swabs or sprays should be applied once or twice : (*a*) one gallon of water, 5 lb. sulphate of iron, half a pint of commercial concentrated sulphuric acid (dissolve the sulphate of iron by suspending it overnight in a piece of sacking in the water contained in a wooden or earthenware vessel, in the morning add the acid slowly to prevent spurting); (*b*) ten gallons of water, one gallon of sulphuric acid. This is effective both for spraying and swabbing. The brush or mop must contain no metal, and the sprayer should be lined with lead. If the disease has been virulent the preceding season, two applications are desirable, one five weeks before the bud-bursting period and another just prior to this event. Where only one application is decided upon, it should be made as near as possible to the bursting of the buds, but care must be taken not to leave it too late, as unexpected sprouting might prevent the work from being carried out at all. (4) In the spring, when the buds are bursting, spraying with Bordeaux mixture (6–4–40) must be undertaken, and another application with the mixture at summer strength (6–4–50), when the later buds are sprouting. Further spraying must depend on weather conditions. Spraying during the blossoming period should be avoided as a rule, but if, through any cause, the application just before blossoming has been delayed and weather conditions are favourable to the disease, the sprayings should be continued rather than risk the spoiling of the entire crop. The sprayings are also valuable in regard to downy mildew, which appears later in the season.

BIOLETTI (F. T.). **Black measles, water berries, and related Vine troubles.**—*California Agric. Exper. Stat. Bull.* 358, pp. 509–524, 3 figs., 3 diag., 1923.

There are several obscure diseases of the vine in California, indiscriminately referred to as black measles, Spanish measles, black mildew, blight, Anaheim disease, California disease, Santa Clara disease, and top disease, which appear to be closely allied to the European 'brunissure' and to two other Californian vine diseases, namely, 'water berries' and 'grape shrivel'.

The chief symptoms of the diseases are various spots, patches, and dead areas on the leaves; spotting, softening, and premature drying of the fruit, with absence of sugar, acidity, colour, and flavour;

dying back of the tips of the shoots, uneven or imperfect ripening of the canes, with a deficiency of starch; dark spots and streaks in the wood; short growth and death of arms, branches, or even entire vines. Various combinations of these symptoms may appear in individual cases. In black measles, Spanish measles, black mildew, California, Anaheim, and Santa Clara diseases (which are distinguishable from one another only by their distribution, the first three being sporadic and the last three epidemic), any or all of the symptoms may occur. These diseases appear to represent a chronic state of the same conditions that produce water berries and grape shrivel, namely, overbearing and malnutrition.

A study of these diseases of the vine in California affords strong evidence that the epidemic form of the trouble is due to excessively heavy crops following good growing conditions and abundant rains, succeeded by deficient or irregular rainfall. The obvious remedy for the disease, besides the application of suitable fertilizers and other cultural measures, is a diminution of the load by short pruning—down to the base-buds in severe cases. The various types of the disease merely represent different stages or degrees of the same trouble. It is very probable that the severity of the final stages of the disease may be due to some undetected infective micro-organism or facultative parasite to which the vine is susceptible only after being weakened by malnutrition.

SWINGLE (D. B.). **How the Department of Botany and Bacteriology has been meeting obligations.**—*Rept. Montana Agric. Exper. Stat. for the year ending 30th June, 1921*, pp. 39–44, 3 figs., 1922.

During the period under review an outbreak of fireblight [*Bacillus amylovorus*] threatened the destruction of the apple industry in Montana but satisfactory control was effected. An investigation of the disease brought to light new facts in connexion with varietal resistance.

Apple scab [*Venturia inaequalis*] was reported in Montana for the first time, and information has been obtained concerning varietal resistance and rapidity of spread. Lime-sulphur was more satisfactory than Bordeaux mixture as a protective spray owing to the serious injury to the fruit caused by the latter.

The results of investigations on brown bark spot of fruit trees, a destructive disease due to malnutrition, have been separately published [see this *Review* ii, p. 221].

A form of plum pockets [*Exoascus pruni*], quite different from the eastern type, destroyed 50 to 90 per cent. of the ordinarily hardy American plums in the Yellowstone Valley. Satisfactory control measures, however, were organized.

Stem rust of wheat [*Puccinia graminis*] has been considerably checked by the vigorous campaign of barberry eradication, in which Montana is one of the leading States. As a result of the serious epidemic in 1916, when the loss to the wheat crop was estimated at three million bushels, there has been no lack of co-operation on the part of the farmers.

A serious wilt disease of sunflowers, caused by a fungus probably identical with *Sclerotinia libertiana*, was widely distributed over

the State. The first symptoms are usually noticed when the plants are four to six feet in height, the affected bases of the stems at first turning black, then brown, and finally yellow. The fungus appears to spread rapidly through the ground, and diseased crowns and roots are generally covered with the dense, white mycelium of the fungus, which afterwards forms large, black sclerotia, especially in the pith. Young seedlings in the field do not appear to be very susceptible to the disease, but the losses among older plants range from 10 to 60 per cent. Inoculation experiments on young sunflower and lettuce seedlings resulted in the production of the typical symptoms of the disease.

OSMUN (A. V.). **The crop disease situation in 1921.**—*Thirty-fourth Ann. Rept. Massachusetts Agric. Exper. Stat.*, pp. 62 a–75 a, 1922. [Rec'd 1923.]

About the usual number of plant diseases was reported from Massachusetts during 1921. On the whole the season was free from serious epidemics, which occurred in three instances only.

An unusually warm and wet spring provided ideal conditions for the discharge and germination of the spores of the apple scab fungus (*Venturia inaequalis*) and resulted in a very severe outbreak of the disease. The McIntosh variety was the most susceptible, showing 90 to 100 per cent. infection in many orchards. A second period of heavy rainfall in July was accompanied by considerable secondary scab infection.

Tobacco wildfire (*Bacterium tabacum*) was extremely prevalent in the seed-beds of the Connecticut Valley, probably owing to the abnormally wet weather during April and May [see this *Review*, ii, p. 37].

The third disease to occur in epidemic form was the downy mildew of cucumber and melon caused by *Pseudoperonospora cubensis*, which resulted in very severe damage except in places where it was held in check by the application of Bordeaux mixture. In no case was the fungicide applied until after the mildew appeared on the vines, and, judging by the successful results, preventive sprays can apparently be dispensed with.

The season was remarkable for the almost complete absence of late blight of potatoes (*Phytophthora infestans*) which was doubtless due to the unusually dry conditions prevailing from August to October.

A complete list of the 166 diseases diagnosed from over 600 cases during the year, together with the localities in which they occurred, is appended.

Annual Report of the Director Arkansas Agricultural Experiment Station, 1921–1922, 103 pp., 35 figs., 1922. [Rec'd 1923.]

The following references to subjects of phytopathological interest occur in the section of the report devoted to plant diseases (pp. 88–94). Apple scab [*Venturia inaequalis*], which was particularly severe during the period under review, was effectively controlled by spraying. Tomato wilt (*Fusarium lycopersici*) is greatly on the increase, and the frequent occurrence of the disease in crops grown from seed on virgin soil, led to experiments by Elliott and Crawford

which have demonstrated that the fungus is carried on seed from infected plants [see this *Review*, ii, p. 92]. Mosaic of sweet potatoes is widespread, and there has been a serious outbreak of mosaic on clovers and cowpeas, the latter sometimes being severely injured and the yield much reduced. On sweet clover [*Melilotus*] the disease is perennial and easily spreads from one plant to another. In the case of the cowpea the disease does not appear to be carried in the seed, but mosaic was found to be transmitted in seed from infected horsebeans and bur clover. A serious epidemic of anthracnose of alfalfa [*Colletotrichum trifolii*] occurred in the Mississippi Valley.

Other important diseases mentioned are cotton blight (*Ascochyta gossypii*), cotton wilt [*Fusarium vasinfectum*], and a bacterial root rot of maize, but the work on these diseases has already been noticed in this *Review* [see ii, pp. 215, 66, and 158 respectively].

RATCLIFFE (G. T.). **The work of the San Antonio Experiment Farm in 1919 and 1920.**—*U. S. Dept. of Agric. Circ.* 209, 38 pp., 4 figs., 1922. [Rec'd 1923.]

The results of experiments on cotton root rot [*Ozonium omnivorum*] extending over the period 1916 to 1919 showed that neither acid phosphate nor calcium acid sulphate fertilizers controlled the disease under San Antonio conditions. Mulching was without effect on the incidence of the disease, and further investigations on the advantages of aeration in infected fields, indicated that any benefit derived from the process was of very brief duration. Root rot was found to occur at a depth of at least four feet.

NEAL (D. C.). **Report of the Plant Pathologist.**—*Ann. Rept. Mississippi Agric. Exper. Stat.*, xxxv, pp. 25–28, 1922. [Rec'd 1923.]

During 1921 about thirty selections of tomatoes were made at the Central Station, Mississippi, from the Norton, Marvel, Norduke, Greater Baltimore, Glove, and Stone varieties, with a view to developing strains resistant to wilt [*Fusarium lycopersici*]. These selections have been re-propagated in wilt-infected land for observation during the coming season. The same procedure is being adopted at the Poplarville Branch Station. So far the yield records have been somewhat unsatisfactory owing to the drought, but there is reason to believe that the wilt-resistant strains will yield better under Mississippi conditions than the ordinary commercial varieties. Attempts at crossing wilt-resistant strains with early commercial varieties are in progress.

A comparative study of resistance and susceptibility of three leading sweet potato varieties (Nancy Hall, Triumph, and Porto Rico) to black rot (*Sphaeronema fimbriatum*) gave inconsistent results, probably owing to the drought, and the work will be repeated. Studies on the surface rot (*Fusarium oxysporum*) of sweet potatoes are also in progress.

Spraying experiments for the control of pecan scab [*Fusicladium effusum*] are being continued at Ocean Springs and Pascagoula with susceptible varieties, such as Pabst, Success, and Delmas. The plots are being sprayed with 4-4-50 Bordeaux mixture and

Bordeaux oil-emulsion at intervals of three to four weeks according to weather conditions.

Forty-first Annual Report Ohio Agricultural Experiment Station for 1921–22.—*Ohio Agric. Exper. Stat. Bull.* 362, 59 pp., 1922.

The following references to plant diseases are included in the report. At Clermont one-tenth and one-twentieth acre plots were planted alternately with diseased and healthy maize seed in order to determine (1) the reduction in yield of grain and stover [the stalks from which the ears have been husked] due to root rot, caused by *Diplodia zeae*, which is very prevalent in the west and south-west of the State, and (2) whether the loss could be eliminated by testing the germination of the seed before sowing. The seed was carefully selected in the autumn of 1921, using the modified rag doll method of germination to determine the relative presence or absence of the disease. In all plots where diseased seed was used there was a marked reduction in the yield both of grain and stover. Production was also much higher on drained than on undrained land. The total yield of grain from healthy seed plots on drained land was 782 lb. and that of stover 550 lb., the corresponding figures for the diseased seed being 486 and 319 lb. respectively. On undrained land the total yield from the healthy seed was 321 lb. of grain and 221 lb. of stover, and from diseased seed 249 lb. of grain and 150 lb. of stover.

It is evident from the above results that the expert use of the rag doll germinator greatly increases the maize yield, but the difficulties connected with the method debar the average grower from taking full advantage of it.

In southern Ohio apple scab [*Venturia inaequalis*] and blotch [*Phyllosticta solitaria*] cause a considerable amount of damage, and spraying experiments on their control were conducted in 1922. The best results were obtained by the use of lime-sulphur 1 in 40 applied (1) when the trees were dormant, (2) when the blossoms showed pink, (3) at petal-fall, (4) a fortnight later, and (5) two months after 4. Bordeaux mixture 3–9–50 and 2–6–50 gave fairly good control but caused considerable russeting of the fruit and defoliation during the latter part of the season. The omission in certain plots of the spray given a fortnight after petal-fall resulted in severe secondary infection by Brooks's spot (*Phoma pomi*) and scab.

Two years of research (for the biennium ending June 30, 1921).—*Pennsylvania Agric. Exper. Stat. Bull.* 170, 31 pp., 1922. [Rec'd 1923.]

The following refereñces in the section of the report devoted to botany and plant pathology (pp. 15–20) are of interest.

Root and ear rots of maize [*Diplodia zeae*, *Gibberella saubinetii* and *Fusarium moniliforme*] cause a considerable reduction in the annual yields of the Pennsylvania crops. The possibility of detecting diseased ears by very carefully controlled germination tests has been demonstrated. The results of field experiments in various parts of the State showed an increase of about six bushels per acre

from healthy ears planted side by side with diseased ones (as determined by the germinator). Such an increase, however, is not regarded as sufficient to warrant the adoption of the germinator test as a part of the general farm routine [see also above abstract].

Co-operative investigations with the United States Department of Agriculture, Bureau of Plant Industry, and Federal Horticultural Board on the morphology and cytology of the causal organism of potato wart disease (*Chrysophlyctis endobiotica*) [*Synchytrium endobioticum*] are being continued. Studies are also in progress on the physiological and anatomical relations of various hosts to the parasite; methods of control by the use of soil sterilization and immune varieties; and the genetical behaviour of immunity and susceptibility of potato varieties to this disease. Infection has not been observed to occur in controlled soil temperature tanks above 22° C., indicating a relatively low temperature requirement. Thirty-four American varieties, including Green Mountain, McCormick, Cobbler, Spaulding Rose, and Burbank, were found to be immune, and 63 out of 149 seedlings. Several varieties of tomatoes have proved to be susceptible. Long-continued steaming of the soil has been found to destroy the sporangia of the fungus, but this method is impracticable for use on a commercial scale. Certain chemicals are effective as regards complete penetration of the soil, but the necessity of giving very heavy applications renders the cost prohibitive.

The results of extensive observations on the incidence of wilt and tuber rots of the potato in the warmer soils of Pennsylvania indicate that at least three fungi, *Fusarium oxysporum*, *F. eumartii*, and *Verticillium* sp. are involved in the causation of these diseases. The results of preliminary trials suggest that a large percentage of infection in the field comes from the soil. Some difference in the varietal resistance of plants inoculated in the field was shown.

Field work on leaf roll of potatoes, begun in 1919, has shown that the percentage of leaf roll in a field may increase in two years from 2·5 to as much as 100 per cent. By the practice of roguing early in the season the percentage of leaf roll plants can be reduced but in none of the trial plots was the disease entirely eliminated by this method. Generally speaking, it does not pay to rogue fields containing over 10 to 15 per cent. of leaf roll. Disease-free seed should be secured whenever possible.

Winter blight of tomatoes, known in Australia as 'spotted wilt' and in Great Britain as 'stripe', is primarily due to a bacterial organism [*Bacillus lathyri*] but unbalanced nutrition of the host and a high degree of humidity were found to be predisposing factors. Greenhouse tomatoes are principally attacked, though outdoor ones may also suffer severely under certain conditions. Conclusive proof of seed dissemination was secured.

The results of four years' work on *Septoria* leaf spot [*S. lycopersici*] of tomatoes show that spraying with standard Bordeaux or other copper compounds increases the total yield of fruits. Under Erie County conditions it is not usually advantageous to spray tomatoes for the canning market.

Three bacterial diseases of tomatoes appeared in Erie County;

the first, apparently a seed-borne disease, resembles the 'Grand Rapids disease', but the causal organism differs somewhat from *Aplanobacter michiganense* [see this *Review*, ii, p. 347]. The second was identical with the canker reported from Michigan and Indiana and recently attributed to *Bacterium exitiosum* Gard, while the third was a wilt apparently caused by *Bacillus solanacearum*.

In 1915 a number of plots on a piece of ground thoroughly infested with club-root of cabbage [*Plasmodiophora brassicae*] were treated respectively with Bordeaux mixture, ammoniacal copper carbonate, formalin, flowers of sulphur, and lump lime. Cabbage was planted on these plots for six years in succession without the treatment being repeated. The residual effect of the treatment was most pronounced in the case of the Bordeaux mixture and lump lime. By the end of the sixth season all the plots were again infested and were treated with copper sulphate, Bordeaux mixture, lump lime, milk of lime, ground limestone, lime-sulphur, and nicotine sulphate. One year's results indicate that Bordeaux mixture (8–8–50), applied in amounts approximately equal to 3,200 lb. calcium oxide per acre, is by far the most satisfactory. Lime-sulphur proved extremely injurious.

Four years' observations on *Sclerotinia libertiana*, the cause of a 'drop' of lettuce and a storage rot of carrots and celery, show that, if non-susceptible crops are grown for two years, the disease will virtually disappear. The sterilization of the soil of frames and seed-beds with formalin (1 in 100 at the rate of 1 gall. per sq. ft.) is recommended. In 1918 two sprayings of lime-sulphur, Bordeaux mixture, or Pyrox, gave satisfactory control of apple rust [*Gymnosporangium juniperi-virginianae*], the first-named being the most effective. In 1919, however, Bordeaux was best, whilst sulphocide and sulphur dust (in 1920) were not satisfactory. Black rot or frog-eye of apples [*Physalospora cydoniae*] can be effectually controlled by the timely application of liquid sprays, dusts being less satisfactory. Most of the infection usually occurs from the time the leaves appear until three or four weeks after the fall of the petals. All attempts to reproduce the disease by artificial inoculation have failed. Apple blotch [*Phyllosticta solitaria*] was well controlled by three applications of lime-sulphur, the first being given 3½ weeks after the fall of the petals. The results of preliminary trials indicate that no infection takes place before 23rd May.

WELLES (C. G.). **Identification of bacteria pathogenic to plants previously reported from the Philippine Islands.**—*Philipp. Journ. of Science*, xx, 3, pp. 279–285, 1922.

The present paper, the first of a series in which all known bacterial organisms pathogenic to Philippine plants will be briefly described, deals with *Bacterium solanacearum*, *Pseudomonas phaseoli*, *Bact. malvacearum*, and *Bacillus nelliae* sp. nov. After a brief review of the records of these diseases in the Philippines, the author describes in detail the cultural and morphological characters of the organisms concerned. The media used were

based on the American descriptive chart and in each case inoculations were carried out to prove the pathogenicity of the organisms.

Bacterium (Bacillus) solanacearum was isolated from wilted tobacco, eggplant, and tomato plants. The cells of the organism measured 0·8 to 1·2 μ in length, Smith's figures being 0·6 to 1·0 μ, and agreed in most cultural respects with the particulars previously published (*U.S. Dept. Agric. Div. Veg. Physiol. & Path. Bull.* xii, p. 1, 1896). *Pseudomonas phaseoli* was isolated from diseased bean leaves, and the organism appears to be identical with that described by Smith in 1901, both from the symptoms and the tests, so far as they were comparable. *Bact. malvacearum*, isolated from young, watery lesions on cotton leaves, agreed with the description of the organism by Rolfs (*South Carolina Agric. Exper. Stat. Bull.* 184, p. 1, 1915), except that no difference in degree of growth was observed on the various sugar media. The bright yellow, non-pathogenic organism mentioned by Rolfs was also encountered by the author in making the inoculations. The bacterial wilt of parsley was for several seasons believed to be caused by *Bacterium solanacearum*, the behaviour of the attacked plants corresponding in all respects with that of those infected by this organism. The result of physiological studies showed, however, that the organism was an entirely new species, which was named *Bacillus nelliae*. The organisms are short rods with rounded ends, 0·83 to 2·27 by 0·37 to 0·50 μ, staining readily with all common aniline dyes. The thermal death point lies between 53° and 54° C. Three to seven peritrichous flagella were demonstrated. Cultural characters are fully described.

THOMAS (R. C.). **A bacterial rosette disease of Lettuce.**—*Ohio Agric. Exper. Stat. Bull.* 359, pp. 197–214, 8 figs., 1922.

Since the autumn of 1919 a bacterial rosette disease of Grand Rapids lettuce has been observed in a number of Ohio greenhouses. The losses caused by the disease, which in many respects resembles that caused by *Rhizoctonia*, vary from a trace to 60 per cent. of the crop.

Affected plants develop unevenly and show a tendency to rosette, accompanied by a yellowing or flaccidity of the outer leaves, especially at high temperatures. Examination of the roots showed them to be seriously affected, the small fibrous roots rapidly ceased to function, and the larger roots were readily detachable when a plant was pulled up. The general cultural conditions prevailing in the greenhouses were excellent.

A microscopic examination of the stems and roots revealed a brownish substance, soluble in alcohol and acetic acid, in the xylem and other portions of the vascular system, and in some cases bacteria extended upwards from half an inch to an inch above ground level. Isolation experiments readily yielded a single species of bacterium, from dead rootlets and soil adhering to diseased plants. Healthy lettuce plants inoculated with pure cultures of the organism developed the typical symptoms of the disease. An inoculation of the soil in which the plants were grown resulted in much slighter infection but the organism was re-isolated from the diseased rootlets and stems in the majority of cases.

The bacterium has never been observed to cause a rot or spots on the leaves or stems of lettuce plants, and negative results were obtained in every case when a suspension of the bacteria was sprayed on the leaves of healthy plants. The chief action of the organism appears to be to gain admission to the vascular system of the plant and interfere with the free passage of food material.

The morphological and cultural characters of the organism are described at length. The bacterium is non-motile, occurring singly or concatenately, 1·4 to 1·9 by ·5 to ·85 μ or ·9 to 1·5 by ·4 to ·8 μ according to the medium, greenish-yellow, later olive-buff and finally red in colour, strictly aerobic, optimum temperature for growth 25° to 27° C., maximum below 38° C., minimum below 0° C., thermal death point 51° to 52° C., remaining viable in artificial media and soil cultures for one year. The organism produced ammonia and some indol, but no acid or gas. There is a marked reduction of nitrates, in which the organism differs from *Bact. vitians* Brown, the cause of a similar lettuce disease in South Carolina. The bacterium is Gram negative, non-acid-fast, withstands desiccation for four days, and will grow in media made alkaline with sodium hydroxide to 20 degrees Fuller's scale, and in various acid-containing media. The group number of the organism, for which the name *Aplanobacter rhizoctonia* n. sp. is proposed, is 211·3333523.

Good results in the control of the disease were obtained by the saturation of the soil, previous to planting, with formalin (3 to 3½ pints to 50 galls. of water), applied at the rate of one or more gallons of liquid per sq. ft. of surface area. The soil was allowed to dry for a week or ten days before the lettuces were planted.

NOBÉCOURT (P.). **Inoculations d'une bactérie phytopathogène à des grenouilles.** [Inoculations with a phytopathogenic bacterium on frogs.]—*Comptes Rendus Soc. de Biol.*, lxxxviii. 13, pp. 1041–1042, 1923.

Inoculation experiments with pure cultures of *Bacillus carotovorus* Jones, isolated from a lettuce in July 1922, were recently carried out on five frogs, all of which died after periods ranging from six to fifty-one days. The animal which survived longest was inoculated with a culture previously heated in order to kill the bacillus. Pure cultures on bouillon of the organism isolated from the dead frogs behaved in all respects like the original cultures and produced the symptoms of rapid decay in carrots. Thus the phytopathogenic properties of the bacillus were in no way impaired by its passage through the animals. The fact that *Bacillus carotovorus* has been proved to be zoopathogenic as well as phytopathogenic is regarded as important from the standpoint of comparative pathology.

ALLYN (O. M.). **Reducing Corn root-rot by careful hand selection of seed.**—*Journ. Amer. Soc. Agron.*, xv, 2, pp. 73–76, 1923.

In Illinois during the spring of 1922 a number of apparently healthy ears were found in a stock of 400 bushels of Western Ploughman seed maize, a smooth variety with blocky kernels, and it was decided to test by germination experiments in the laboratory

and by planting in the field [see above p. 442] the relative merits of the ears showing no disease, of those going into the general run of seed, and of those badly diseased, the ears being grouped into these three grades before shelling.

Composite samples for germination tests were taken from the bags after shelling, both the plate and blotter, and rag doll methods being used. In each test 200 kernels were placed in a germinating cabinet at a temperature of 80° F. and dissected and examined after seven days. The results of all the tests may be summarized as follows: selected seed gave 91·1 per cent. healthy and ·96 per cent. dead, 'general run' seed 69·7 per cent. healthy and 3·7 per cent. dead, and diseased seed 52·3 per cent. healthy and 12·5 per cent. dead.

When samples of the above seed were planted on a comparatively new piece of ground, the following yields were obtained: selected seed, 73·7 bushels shelled maize per acre; 'general run' seed, 65·8 bushels; diseased seed, 64·2 bushels. The largest number of disease-free ears (67·6 per cent.) came from the selected plot: 31·2 per cent. from the 'general run', and 13·8 per cent. from the diseased plot. These results show that careful hand selection materially reduces root rot [*Diplodia zeae*] even in the first year.

ROSEN (H. R.). **A bacterial disease of Foxtail (Chaetochloa lutescens).**—*Ann. Missouri Bot. Gard.*, ix, 4, pp. 333–385, 7 pl. (2 col.) 1 graph, 1922. [Rec'd 1923.]

A bacterial disease of foxtail, first recorded by the author in Arkansas in 1919, has since been studied in more detail especially with regard to its symptoms and etiology. No systematic attempt has been made to discover the disease on other grasses, but the results of artificial inoculation experiments show that the pathogen can infect wheat, oats, rye, barley, maize, Sudan grass (*Holcus sorghum sudanensis*), millet, and perennial foxtail. On oat and barley seedlings the disease may cause serious damage.

The lesions on foxtail appear as light or dark brown spots of no definite size or shape; they are most frequently found on the blades and sheaths. On other hosts the symptoms vary from light yellow, indefinite areas (often with a reddish tinge in the case of oats) to greyish-green, withered spots. The invaded tissues swarm with bacteria which cause discoloration, disintegration, and finally death. The organism was not difficult to isolate and artificial inoculations were readily successful when the bell jars used were properly aerated. Temperature plays an important rôle in infection, which does not occur on plants incubated below approximately 21° C., whilst above 24° C. infections are effected, and about 32° C. the symptoms appear in 24 to 48 hours. Admission is gained by means of stomata and water pores.

The disease appears to be different from any other known bacterial affection of grasses. The causal organism, *Pseudomonas albopreципitans* n. sp., is described as follows: narrow rods with rounded ends, solitary or in pairs, averaging 0·6 by 1·8 μ, motile by a single polar flagellum; no spores, zoogloea, or irregular forms; capsules present; strictly aerobic; surface colonies on nutrient agar white, round, raised, smooth, amorphous, sticky, margins entire,

surrounded by colourless areas followed by a white precipitate on media testing acid as P_H 6·6; nitrates reduced to nitrites; ammonia produced, but no indol, hydrogen sulphide, acid, or gas; diastatic action strong; fair growth in Uschinsky's and Fermi's solutions; minimum temperature for growth 0° C., optimum 30° to 35° C., maximum about 40° C., thermal death point 41° to 43° C.; not sensitive to drying or freezing and only slightly so to sunlight; Gram negative, non-acid-fast. The group number is 5322–31220–1333.

The meaning of hydrogen-ion concentration, its relation to titratable acidity, the methods of measuring it, and the necessity of utilizing it in the study of bacterial pathogens are discussed. Comparisons are given between Fuller's scale and P_H values. Numerous cultural reactions are presented, and the relationship of various organic anions to growth and several questions of technique are discussed.

Beef extract was found to be the probable source of the white precipitate (a phosphate) in media containing the extract.

A bibliography comprising nearly a hundred titles is appended.

MUNRO (D. G.) & SUNDARARAMAN (S.). **Coffee-spraying experiments.**—*Planters' Chron.*, xviii, 14, pp. 193–196, 1923.

A series of experiments was undertaken at the Purchikadu (Sidapur) estate [India] to ascertain (*a*) to what extent leaf diseases of coffee, such as red rust (*Hemileia vastatrix*) and black rot [*Corticium koleroga*] could be checked by spraying; (*b*) the optimum strength of solution for efficacy and economy; (*c*) the efficacy of different kinds of adhesives when added to Bordeaux mixture; and (*d*) whether the improvement in the health of the plant and the gain in yield compensated for the cost of the work. The spraying was carried out in May to June 1922 under adverse weather conditions, the experimental area being divided into plots of about one acre in extent. The results may be summarized as follows. Two per cent. Bordeaux mixture 10–10–50 with resin adhered well to the leaves and caused no injury to the foliage, whilst almost equally good results were obtained by the use of half strength Bordeaux (5–5–50) plus resin or casein, and even quarter strength Bordeaux ($2\frac{1}{2}$–$2\frac{1}{2}$–50) with resin or casein, was also very satisfactory. Casein is recommended as cheaper and easier to manipulate than resin soda. Fish oil soap was found not to be a good adhesive. Lime-sulphur $7\frac{1}{2}$–$7\frac{1}{2}$–50 was washed off the leaves by the heavy rains of the monsoon.

The value of the treatment may be gauged by the fact that the leaves produced in the April to May (1922) flush remained on the sprayed trees till February 1923, by which time the trees in the unsprayed controls had lost nearly all the leaves of the September flush. Die-back was much less prevalent in the sprayed than in the untreated plots.

Spraying is both difficult and expensive especially where water is scarce. Large sprayers are unsuitable, and the frequent filling of small ones, together with the preparation of the mixture, entails considerable time and care. The time for spraying is limited by climatic conditions to about four weeks from 1st May to 1st June.

Efforts are being made to obviate the various difficulties in connexion with the treatment by devising a dry fungicide which can be dusted on the plants either in a heavy dew or light shower of rain.

BRITON-JONES (H. R.). **A wound parasite of Cotton bolls.**—*Min. Agric. Egypt Tech. and Sci. Serv. (Bot. Sect.) Bull.* 19, 8 pp., 2 pl. (1 col.), 1923.

Black mould (*Rhizopus nigricans*) causes a severe rotting of the bolls of Indian, American, and native varieties of cotton in Upper and Lower Egypt.

The fungus, a common facultative parasite, gains admission to the plants through the wounds made in the bolls by the attacks of the pink boll worm (*Gelechia gossypiella*) and the boll worm (*Earias insulana*). Two days after infection the boll becomes soft and turns reddish-brown or greenish-black. At this stage a slight touch will cause the boll to break off at the junction between the base of its stalk and the main axis. Two or three days later the boll hardens and dries up, thereby causing a premature splitting along the sutures. The stem immediately under the affected boll also turns reddish-brown, becomes shrunken and hard, and is not readily detached by contact or by the wind. The boll does not open out completely and the production of numerous sporangia by the fungus imparts an olive-green or dirty appearance to the fibre. The bolls thus affected have been described by Willcocks as 'Mabroom' bolls (*Sultanic Agric. Soc.*, 'The insect and related pests of Egypt,' i, 1916).

The disease is most prevalent from the latter part of June onwards and reaches its climax during the late summer, which is the period of the maximum activity of the boll worms. The atmospheric humidity caused by the advance of the Nile flood at this season also contributes to the rapid growth of the fungus.

In 1920 out of 10,537 bolls examined at the Giza Experiment Station, 795 were attacked by *R. nigricans* and in 735 of these the fungus was associated with the boll worm. By inducing premature opening of the bolls the fungus facilitates the entry of the cotton seed bug. Infected bolls cannot be saved and the disease can only be controlled by preventing the attacks of the boll worm.

An important question which arises in connexion with the attack of *R. nigricans* is the relation between the fungus and the boll worm, but at present this relationship is merely a matter of conjecture.

PAPE (H.). **Ein neuer, auf Schneeglöckchen (Galanthus nivalis L.) schmarotzender Brandpilz (Urocystis galanthi n. sp.).** [A new smut (*Urocystis galanthi* n. sp.) parasitic on the snowdrop (*Galanthus nivalis* L.).]—*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, xi, 4, pp. 331–336, 7 figs., 1923.

In January 1921 the leaves, leaf-sheaths, and spathes of snowdrops collected from a garden near Berlin for experimental purposes were found to be partially or totally covered with lead-coloured, callus areas, measuring 5 to 50 by 3 to 5 mm. Closer examination revealed the presence of the mycelium of a species of

Urocystis, dark brown spore masses being formed in the parenchymatous tissues of the leaves. The spore balls consisted of one, two, or occasionally three or four primary spores in the centre, and numerous secondary spores situated at the periphery. They were globular to ellipsoid and measured 23 to 51 μ across, whilst the primary spores averaged 14 by 21 μ. When fully developed the secondary spores formed a firm, single, compact layer of smooth, light-brown spores, 7 to 14 μ in diameter and globular to irregular in shape.

The hyphae, which were about 4 μ in breadth, hyaline, and intercellular, were detected only in the tissues surrounding the spore balls. Here and there, ramified or lobed haustoria were produced. The intercellular spaces were much enlarged by the formation of the spore masses.

Attempts to germinate the spores were unsuccessful, probably because the resting period allowed was not long enough. Natural infection of the snowdrop appears to take place in the very early spring, the fungus probably remaining quiescent during the following summer, autumn, and winter. The presence of the fungus in the first shoots of the plant indicates that it overwinters in the bulb.

The snowdrop smut is in all probability closely related to *Urocystis leucoji* Bubak, which attacks *Leucojum vernum*, another member of the Amaryllidaceae, and to *U. colchici*, which is found on numerous Liliaceae. The snowdrop parasite, however, differs in various morphological particulars from the published descriptions of *U. leucoji* and *U. colchici* (a comparative table of which is given), and the creation of a new species, *U. galanthi*, is believed to be justified.

WARE (W. A.). **Violet felt rot (Rhizoctonia) of Clover.**—*Journ. Min. Agric.*, xxx, 1, pp. 48–52, 6 figs., 1923.

So far as the author is aware, this is the first record of the occurrence of *Rhizoctonia violacea* on red clover in England, although it has already been described as attacking this host on the continent. The fungus is well known as causing injury to many other cultivated plants, such as seakale, carrots, potatoes, lucerne, &c., but it has yet to be proved whether it can pass from other host species to clover, or whether specialized races or forms of the fungus exist.

The disease was first noticed at the end of November 1922 in a field of red clover attacked by stem rot (*Sclerotinia trifoliorum*), but it was quite evident that *Rhizoctonia* was present as a parasite on the clover, and was not merely saprophytic on plants or parts of plants previously killed. Whether primary infection was aided by the mild conditions prevailing in the early winter of 1922 is not known; it is possible that the occasional frosts were responsible for stirring into activity the dormant sclerotia of the *Rhizoctonia* which may have been present in the soil. The *Rhizoctonia* was first recognized on the stubble of the previous oat crop, the violet-brown mycelium being fringed with white at its growing extremity. Affected clover plants were dwarfed and stunted and frequently showed the leaves in a dying condition. On digging up and

carefully washing attacked plants the violet-brown mycelium could be seen just at and below the soil level.

The fungus attacks the main root and its branches, covering them with minute, twisted, brown strands, and penetrating the outer cork layers of the root at various points, forming sclerotial bodies [corps miliaires, infection cushions] which may possibly function also as suckers. The layers in contact with these sclerotia are apparently killed and the rot proceeds until the whole of the main root system is involved.

The plants, in the majority of cases, make an effort to recover by developing adventitious roots from the base of the crown, and under favourable conditions the effort may be successful, the new root system not being observed to be attacked. In addition to the killing of a certain number of plants, however, patches of the clover may be retarded, dwarfed, weakened, and somewhat thinned.

Besides red clover, the *Rhizoctonia* was found attacking living plants of corn mint (*Mentha arvensis*), meadow grass (*Poa*), speedwell (*Veronica agrestis*), and a dead plant of knotgrass (*Polygonum aviculare*), but in none of these cases were sclerotia found.

No experiments in the control of the disease on clover have yet been made. Having regard, however, to the probability of the sclerotia set free in the soil remaining dormant for some years, it is suggested that infected soil should be given as long a rest from clover as possible, an interval of over eight years being advisable.

PUTTERILL (V. A.). **Silver leaf disease of fruit trees and its occurrence in South Africa.**—*Dept. of Agric. S. Africa, Bull.* 27, 19 pp., 10 figs., 1923.

Silver leaf in South Africa is making headway, chiefly owing to the indifference shown to the disease by growers. The two types, 'false' silver leaf, due to physiological causes and often of a non-permanent character, and true silver leaf due to the parasitic fungus *Stereum purpureum*, are mentioned and a description of the symptoms and effects of the latter is given.

The disease has been reported from different parts of the Union, but as silvering of the foliage was the only diagnostic character available, many of the cases must be referred to false silver leaf. A fungus found on peach trees near Pretoria and on an unknown host at Maritzburg, Natal, could not be referred to *S. purpureum* with absolute certainty. In the Western Cape Province true silver leaf disease has occurred at Stellenbosch, Wynberg, and Paarl, on plums, apricots, peaches, and sometimes on apples.

The fruiting bodies of the fungus occur more rarely in South Africa than in England, probably owing to the climatic conditions and also perhaps to different methods of planting and culture, which in South Africa are not favourable to fungal development. On the other hand, the virulence of *S. purpureum* may increase with time, as has been the case with *Schizophyllum commune*. Fruiting bodies of *S. purpureum* have been found on *Populus alba* near Capetown, and observation has shown that fruit trees in close proximity to poplars constantly develop silver leaf. As the latter trees are generally grown in damp situations, the ready fruiting of the fungus on them is only to be expected. The identity of the

South African fungus was confirmed by British workers as *S. purpureum*, although some of the specimens sent bore hairs on the hymenium, a characteristic of *S. rugosiusculum*, which species, however, is now held to be not specifically distinct.

In South Africa very little is known about the relative susceptibility of the different varieties. Of plums, Kelsey seems particularly susceptible. Generally speaking, plums and peaches appear to suffer more than other fruit trees, but inoculation experiments on apricots, apples, and pears were also successful, while the results on loquat were doubtful.

The control measures recommended consist of the cutting out and burning of all discoloured wood including the branches which show silvering, the pruning tools being dipped in a 10 per cent. solution of formalin after use. Large pruning wounds should be pared and treated with Stockholm tar or some good paint. As the disease is supposed to make more rapid headway in heavy soils and in damp situations, liming must not be neglected.

There are no legislative regulations in South Africa similar to those in force in England regarding this disease, but it is in the growers' own interests to take energetic measures to control it.

Plant diseases in the Western Cape Province VII. Silver leaf disease of fruit trees.—*Journ. Dept. Agric. S. Africa*, vi, 3, pp. 233–236, 4 figs., 1923.

This is a more popular account of the disease discussed in the preceding paper.

Borg (J.). **Cultivation and diseases of fruit trees in the Maltese Islands.**—*Govt. Printing Office, Malta*, 622 pp., 1922.

This valuable compilation deals with the cultivation and diseases (due to fungi, insects, and physiological causes) of the following Maltese fruit and nut trees: citrus (eight varieties), olive, carob (*Ceratonia siliqua*), fig, black and white mulberry, pomegranate, pear, apple, medlar, Azarola thorn (*Crataegus azarolus*), almond, peach and nectarine, plum, apricot, cherry, walnut, pistachio (*Pistacia vera*), stone or edible pine (*Pinus pinea*), kaki or Chinese date plum (*Diospyros kaki*), banana, prickly pear (*Opuntia ficus-indica*), date palm, vine, gooseberry, currant, raspberry, and strawberry. Various other trees are mentioned but the diseases attacking them are not of sufficient importance to justify enumeration. The cultivation and diseases of the vine are discussed at considerable length, and throughout the book there are many useful suggestions on control measures and the application of appropriate cultural methods.

Gossard (H. A.) & Walton (R. C.). **Dissemination of fireblight.**—*Ohio Agric. Exper. Stat. Bull.* 357, 126 pp., 14 fig., 1 diag., 1922.

These investigations, commenced in 1915, were carried out to elucidate the spread of the fireblight organism (*Bacillus amylovorus*). It was first found that this organism was capable of living in honey for 72 hours or more. Apple twigs inoculated with honey drawn from three different hives developed fireblight and from two

of the twigs the fireblight organism was recovered. Tender twigs, inoculated with apple pollen removed from the baskets of bees caught as they were entering the hive, died in several cases, presumably from fireblight, though the organism was not isolated. Mouthparts of bees, caught during the blossoming period and inserted into tender twigs, resulted in the death of the latter, almost certainly from fireblight, though again the organism was not recovered. The results of further tests showed that the organism was capable of living in aphid honey dew for seven days, and in peach, plum, and cherry nectar for five days or longer. The records showed an average of 64·5 per cent. infection of the nectar from peach blossoms, 74 per cent. from plum, and 94 per cent. from cherry.

Rain was proved to be a most important agent for the spread of infection over trees where centres were already established, especially if these were near the top. It was estimated that 50 to 90 per cent. of all blossom infection is accomplished by rain water.

Susceptibility to fireblight was shown to be greatly reduced in blossoms pollinated 72 hours previously, while blossoms 144 hours after pollination were immune from the disease. From this it may be inferred that the presence of bees in an orchard is desirable, since they hasten the flowers past the period of susceptibility to fireblight, and it is advisable therefore to encourage pollination before the blight wave sets in. In one case the initial infection of a young pear orchard was found to have originated through blossom blight.

Several sucking and boring insects were observed to be carriers of fireblight, and in general it may safely be stated that any contaminated insect, either of the biting or sucking class, is a potential insect of transmission. Attempts to prove that ants were responsible for spring infection on a large scale met with negative results, as also did the attempted isolation of the blight organism from the bodies of aphids, aphid wax, and syrphid larvae taken from living blight cankers. The possibility of the organism surviving in the intestinal tract of bees appears so remote as to be negligible.

The application of the ultra-violet rays to leaves and twigs to test their destructive action on the fireblight organism gave negative results.

The writers believe there is ample ground for suspecting that fireblight travels northward with the zone of blossoming more extensively than is generally accepted.

Directions for spraying fruits in Illinois.—*Illinois Agric. Exper. Stat. Circ.* 266, 15 pp., 2 figs., 1923.

The standard sprays used in the control of fungous diseases of Illinois fruit are described in the present paper, which is particularly designed to meet the requirements of smallholders.

Apples. (1) Dormant spray of lime-sulphur or oil emulsion primarily for the control of San José scale; (2) cluster-bud spray of lime-sulphur (1½, or 4 lb. dry, in 50) and lead arsenate (2 lb. paste or 1 lb. powdered), chiefly for the control of scab [*Venturia inaequalis*]; (3) calyx spray, similar to 2 and applied for the same purpose; (4) one week after petal fall as in 2 and 3; (5) a fortnight after fall of petals; same formula as 2, 3,

and 4 for the control of blotch [*Phyllosticta solitaria*], scab, codling moth, curculio, and leaf spot [*Physalospora cydoniae*]; (6) three weeks after fall of petals: same formula and objects as 5; (7) four weeks after fall of petals (for blotch only): same formula as above, minus the lead arsenate; (8) five weeks after fall of petals: as in 7. Wherever attacks of bitter rot [*Glomerella cingulata*] are anticipated, four applications of Bordeaux mixture should be given at intervals of ten days from the first week in July.

CHERRIES. (1) Lime-sulphur (1, or 2½ lb. dry, in 50) and lead arsenate (3 lb. paste or 1½ powdered) for the prevention of brown rot [*Sclerotinia cinerea*], leaf spot [*Coccomyces hiemalis*], and curculio, to be applied just before the opening of the buds; (2) similar to 1 and for same reasons, to be given immediately after fall of blossoms; (3) as preceding, to be applied as above, ten days after 2 in case of damp, close weather only.

PEACHES. (1) Dormant lime-sulphur spray (5½, or 15 lb. dry, in 50), for the control of San José scale and leaf curl [*Exoascus deformans*], to be applied in late autumn or early spring; (2) four weeks after fall of petals, self-boiled lime-sulphur (8–8–50) and lead arsenate (3 lb. paste or 1½ powdered) for the control of scab [*Cladosporium carpophilum*], brown rot [*Sclerotinia cinerea*], and curculio; (3) for midseason and late varieties, another application, as in 2, should be given against brown rot from four to five weeks before the fruit ripens; (4) in the event of damp, close weather, an additional lime-sulphur (8–8–50) spray should be applied a fortnight before picking.

PEARS. (1) Dormant spray as for apples; (2) cluster-bud spray as for apples for the control of scab [*Venturia pirina*] and curculio; (3) calyx spray as for apples for control of scab, codling moth, and curculio; (4) three weeks after fall of petals for the control of smudge and insects: as in cluster-bud spray for apples.

PLUMS. (1) Dormant spray as for apples; (2) as in first summer spray of cherries for the control of leaf diseases, brown rot [*Sclerotinia cinerea*], and curculio; (3) and (4) same as 2, to be applied immediately after blossoms fall and ten days later respectively; (5) additional applications of lime-sulphur lead arsenate should be given at fortnightly intervals until a month before picking in wet seasons.

BRAMBLES. Anthracnose of black raspberry [*Gloeosporium venetum*] may be controlled as follows: (1) lime-sulphur (1 in 20) applied before growth starts in spring; (2) lime-sulphur (1 in 40) when new shoots are 6 to 8 inches high; (3) lime-sulphur (1 in 40) just before blossoming.

CURRANTS and GOOSEBERRIES. Spraying for leaf spot [*Mycosphaerella grossulariae*] should begin when the leaves are unfolding and be repeated at fortnightly intervals until five applications have been made, Bordeaux mixture being used. Gooseberry mildew [*Sphaerotheca mors-uvae*] may be controlled by six applications of liquid lime-sulphur (1 in 40) given at ten-day intervals from the opening of the buds.

GRAPES. Most diseases can be combated by a combination spray of Bordeaux mixture and lead arsenate applied at the following times: (1) as the leaf buds are opening; (2) immediately after

fall of bloom; (3) ten days after fall of bloom; (4) twenty days after fall of bloom. The last two applications should be of double strength lead arsenate.

STRAWBERRIES. Leaf spot [*Mycosphaerella fragariae*] may be controlled by spraying with Bordeaux mixture (1) as the plants begin growth: (2) just before blossoming; and (3) just after blossoming.

Full directions are given for making and mixing the standard sprays.

GARDNER (M. W.). **Apple blotch control.**—*Trans. Indiana Hort. Soc. 1921*, pp. 184–185, 1922. [Rec'd 1923.]

Apple blotch [*Phyllosticta solitaria*] is gradually spreading northwards in Indiana. The most reliable fungicide for its control is Bordeaux mixture 4-4-50 or 4-6-50, but lime-sulphur may be substituted in cases of varieties liable to russeting, such as Ben Davis. Sulphur and Bordeaux dusts reduce infection to some extent but are not so efficient as liquid Bordeaux. The best results are secured by the 2-4-6-10 week schedule. In planting new orchards the use of susceptible varieties, such as Northwestern Greening, should be avoided.

FISHER (D. F.). **Spoilage of Apples after harvest.**—*Rept. Proc. Thirty-second Ann. Convention Brit. Columbia Fruit-Growers' Assoc. held at Victoria, B. C. 18th to 20th Jan. 1922*, 68 pp., 1922.

Storage diseases greatly reduce the harvested crop of apples and at the same time increase the cost and risk of market operations. It is almost impossible to form any conception of the importance of these diseases unless the fruit can actually be traced to the ultimate consumer, but certain useful data may be collected from the records of the United States Bureau of Markets. The terminal markets' inspection reports indicate that in 1919, out of 2,973 cars examined 23·7 per cent. were infected with blue mould (*Penicillium expansum*), representing the parasitic group of storage diseases, and 1·6 per cent. with scald, one of the principal physiological affections of stored apples. In 1920, of 3,462 cars examined 60·6 per cent. were infected with blue mould and 13·3 per cent. with scald.

P. expansum is normally incapable of penetrating the unbroken skin of the fruit and does little harm to the crop on the trees, although it has been observed to do so following injury by codling moth. In commercial storage and in transit it probably causes 80 to 95 per cent. of the total rots, while in the local markets and home storage the losses are estimated to exceed 10 per cent.

The fungus most frequently enters through stem punctures, but sometimes through finger-nail scratches by pickers, insect injuries, scab spots, bruises and all kinds of wounds. The disease may spread from one apple to another by the dissemination of the spores or by actual contact. Low temperatures greatly delay the development of the mould, more particularly at the inception of decay than during its later development, rots starting while the apples were warm, developing rapidly even at 32° F. The losses

from the disease may be greatly minimized by careful handling, early cooling of the apples to 32° F., and securing sanitary conditions in the packing houses.

Apple scald causes more losses than all the other [physiological] storage diseases combined, being particularly severe on York Imperial, Grimes, Black Twig, Arkansas Black, Rome, and Stayman. It can be distinguished from all other apple diseases by its preference for the greener side of the fruit, the flesh of which is sometimes decayed to a depth of half an inch.

The influence of temperature on the production of scald has been demonstrated experimentally. In general, apples held at 60° to 70° F. scald three to four weeks earlier than those held at 50°; those at 50° about four weeks earlier than those at 40°; and those at 40° about three weeks earlier than those at 32°. The higher temperatures are frequently encountered in cases of delayed storage. The time immediately following picking is a critical period during which refrigeration is urgently required. There are, however, other factors besides temperature to be considered. The green portion of the skin is most susceptible to scald, and measures to secure proper colouring of the fruit are desirable.

Investigations have also been carried out which indicate that humidity has no effect upon the development of the disease except where actual drops of moisture form on the apple, when probably the harmful effects are primarily due to the partial exclusion of the air or the retention of oxidation products by the apple. The experiments demonstrated that accumulations of carbon dioxide (1 to 6 per cent.) tend to prevent, rather than promote the development of the disease, and apples susceptible to scald were rendered immune by storage for a few days in an atmosphere of pure carbon dioxide.

The conclusion was also reached that abnormal respiratory conditions consequent upon poor aeration are largely responsible for scald. It was shown that a constant air movement of from one eighth to one quarter of a mile per hour either entirely prevented scald or reduced it to a minimum. The intensity of the air movement was apparently more important than its continuity, and the circulation of the air more important than its renewal. Thorough aeration during the first eight weeks of storage was of much more value than later.

These results show that scald is due to some product which can be carried away by air or possibly taken up by absorbents. Further tests in which apples were enveloped in paper impregnated with various gas-absorbing substances (paraffin, vaseline, and olive oil), or surrounded by sawdust, animal charcoal, or corn starch, gave convincing evidence that scald can be prevented by the absorption of the gases (other than carbon dioxide) given off by the apples themselves. The odorous constituents of the apple were suspected and experiments showed that typical scald effects could be produced by exposing the fruit to the esters of amyl acetate and amyl formate.

On the whole the treated wrap method, which provides each apple with its own preservative, appears to be the best and most reliable preventive of scald. Further experiments are in progress

to ascertain the relative efficiency of the various mineral oils and the exact quantities required.

LUDWIGS (K.). **Bericht über das Auftreten der Spitzendürre (Monilia) bei Kirschen in der Provinz Brandenburg im Jahre 1922.** [Report on the occurrence of withertip (*Monilia*) of Cherries in the Province of Brandenburg in 1922.]—*Deutsche Obst- und Gemüsebauzeit.*, lxix, 12, pp. 91-92, 1923.

The replies to a circular letter of inquiry issued by the Brandenburg Chamber of Agriculture in co-operation with the Plant Protection Head-quarters at Dahlem, Berlin, indicate that, in general, the *Monilia* disease of cherries was much less severe in Brandenburg in 1922 than for some years previously. It is believed that the drought of 1921, which allowed of a complete ripening of the wood of young shoots, was largely responsible for the comparative absence of the disease. The brief duration of the blossoming period in 1922 was also unfavourable to the fungus.

The following varieties were generally resistant: Früheste der Mark, Hedelfinger Riesenkirsche, Grosse Prinzess, Königsknupper, Gassin's Herz, Saure Natte, Ostheimer Weichsel, Königin Hortense, Guben's Ehre, and Podbielski; whilst susceptible varieties were Shade Morello, Doppelte Natte, Grosse Gobet, Rote Glaskirsche, Ochsenherzkirsche, and Diemitz (slightly). Treatment with lime-sulphur mixture or solbar was reported to be more efficacious than the application of Bordeaux mixture or carbolineum.

HÖSTERMANN (G.) & NOACK (M.) **Das Rutensterben der Himbeeren.** [The die-back of Raspberry canes.] — *Deutsche Obst- und Gemüsebauzeit.*, lxix, 20, p. 153, 1923.

The die-back of raspberry canes caused by *Didymella applanata* [see this *Review*, ii, p. 128] is constantly increasing in severity and a particularly virulent form of the disease, resulting in the production of 'witches' brooms' on the canes, has been observed in some parts of central Germany. None of the well-known varieties appears to be immune from the disease, which may be controlled to some extent by spraying the young shoots with solbar or Bordeaux mixture, liming the soil, using artificial fertilizers in preference to fresh organic manure, and by removing and burning diseased shoots.

It is recommended that nursery gardeners and other purchasers of raspberry canes should insist upon guarantees to the effect that the material is free from die back.

GRAULUND (R.). **Ein gutes Mittel gegen den amerikanischen Stachelbeermehltau.** [A good remedy for American Gooseberry mildew.]—*Deutsche Obst- und Gemüsebauzeit.*, lxix, 21, p. 163, 1923.

At Eskilstuna (Sweden) the American gooseberry mildew [*Sphaerotheca mors-uvae*] has been successfully combated by the application of a 6 to 7 per cent. solution of the best quality of soft soap at the rate of 2 to 3 litres per bush. The soft soap solution completely destroys the conidial stage of the mildew but not the perithecial stage. Vigorous young bushes require repeated sprayings

during the summer, but for mature bushes one application given in the evening or when the sky is overcast, usually suffices. Very occasionally a negligible russeting of the foliage or dropping of the fruit may ensue.

Rose mildew [*Sphaerotheca pannosa*] has been controlled by 3 to 4 per cent. solutions of the same material.

TISDALE (W. H.), TAYLOR (J. W.), & GRIFFITHS (MARION A.) **Experiments with hot water, formaldehyde, copper carbonate and chlorophol for the control of Barley smuts.**—*Phytopath.*, xiii, 4, pp. 153–160, 1923.

The results obtained by the use of various seed treatments for the control of loose smut (*Ustilago nuda*) and covered smut (*U. hordei*) of barley are given in this paper.

Experiments begun in the autumn of 1919 on three varieties of barley, in which seed was either (1) presoaked 4 to 6 hours, immersed in water at 52° C. for 10 minutes and then dried, (2) immersed 10 minutes in formalin (1 in 320), covered overnight and spread to dry, or (3) sown without treatment, were interesting, as the second treatment produced plants as free from loose smut as the hot water treatment, normally used against this disease.

Similar experiments were carried out in 1921 and 1922 using five varieties of barley. Full figures regarding these experiments are given. They show that formalin was just as effective in controlling loose smut as the modified hot water treatment (0·1 against 0·15 per cent. infection) whilst it is less effective against covered smut (4·4 against 2·16 per cent.) for which it has been recommended. Little was gained in the yields, however, by either treatment. Varieties differ in their response to the treatments, which might be recommended for some and not for others.

In the autumn of 1921, chlorophol, an organic mercury compound, and copper carbonate were tried on heavily smutted seed and the results of the year's trial were striking. Copper carbonate, though favourable to the germination of the seed, did not satisfactorily control either of the barley smuts, whilst chlorophol was very effective, reducing the percentage of loose smut from 0·82 to 0·15 and covered smut from 5·08 to 0·45 and causing increased germination.

HEALD (F. D.), ZUNDEL (G. L.), & BOYLE (L. W.). **The dusting of Wheat and Oats for smut.**—*Phytopath.*, xiii, 4, pp. 169–183, 1 fig., 1923.

In this paper the authors give results obtained in the control of bunt of wheat [*Tilletia tritici* and *T. levis*], some of which have been previously noticed [see this *Review*, ii, p. 264], and also figures relating to the efficiency of copper carbonate in controlling oat smut (*Ustilago levis*).

The new experiments recorded on bunt consisted of a series of farm demonstrations to show the comparative effect of copper sulphate, formalin, and copper carbonate in the control of bunt carried out in 1921–22. In the autumn of 1921 over 10,000 acres in Washington were seeded with wheat treated with copper carbonate (2 oz. per bushel) and the results compared with those of the farmers'

own treatment with copper sulphate or formalin. The average percentages of bunt for the various treatments were as follows:—copper sulphate 10·9, copper carbonate 7·2; copper sulphate + lime afterbath 11·0, copper carbonate 8·5; formalin 9·1, copper carbonate 3·1; formalin + lime afterbath 10·2, copper carbonate 3·4. Seed treated with copper carbonate germinated 1 to 5 days earlier than normal and there was very little seed injury, whilst with copper sulphate and formalin severe injury resulted in a number of cases.

In the first experiment against oat smut, carried out in the spring of 1922, five field demonstrations were made to test the comparative value of the standard treatment and copper carbonate 2 oz. per bushel. The average percentage of smut in the five demonstrations were as follows: untreated 8·9; formalin 0·20; formalin + lime afterbath 1·10; copper carbonate 1·17.

In a second experiment against oat smut, artificially smutted seed of the varieties Swedish Select, Abundance, and Chinese Hull-less was treated with copper carbonate at the rate of 2 oz., 3 oz., and 4 oz. per bushel, and the average percentages of smutted panicles were 3·01, 2·14, and 2·26 respectively whilst the control gave 39·12. The most striking figures were obtained with the hull-less variety, Chinese Hull-less, for which the figures were 0, 0, 1·00 and the control 70·45. The use of 2 oz. copper carbonate gave practically as good control as larger amounts. The protection afforded by copper carbonate, however, was not equal to that ordinarily obtained with standard formalin treatment.

Fraser (W. P.) & Simmonds (P. M.). **Co-operative experiments with copper carbonate dust and other substances for smut control.**—*Scient. Agric.*, iii, 9, pp. 297–302, 1923.

In 1922 a series of experiments in the control of bunt of wheat (*Tilletia tritici* and *T. levis*) was conducted at the Saskatchewan Laboratory of Plant Pathology, in co-operation with the Dominion Experimental Farms at Indian Head, Scott, and Rosthern (Saskatchewan), and Lacombe (Alberta). At Indian Head the treatments were also tried on oats against smut (*Ustilago levis*). The treatments tested were (1) formalin, 1 in 320, immersion for five minutes and subsequent covering for one hour; (2) copper carbonate 2 oz. per bushel; (3) a mixture of dehydrated copper sulphate dust and hydrated lime (0·43 lb. to 0·57 lb.), 2 oz. per bushel. The fourth plot was left untreated as a control.

In all the experiments the formalin gave perfect control. Copper carbonate was effective where the bunt percentage was low, while copper sulphate and lime was less satisfactory. Both in field and greenhouse tests formalin appreciably retarded g wth. For wheat the percentage of germination averaged 82·78 for formalin, 93·56 for copper carbonate dust and 94·90 for copper sulphate and lime dust, against 96·64 for the control, whilst the average percentages of bunt in the resulting crops were 0, 0·65, 1·98 and 12·26 respectively. For the single trial on oats the corresponding figures were 93·6, 96·6, 97·6, 95·3 and 0, 1·0, 5·6, 7·5 respectively. Additional trials will be carried out with copper carbonate, which presents several advantages over formalin.

Further tests on wheat were made with copper carbonate mixed

with lime, infusorial earth, and talc, as well as with various combinations of copper sulphate, Bordeaux mixture, and sulphur dust. The last-named reduced the amount of bunt to 2·5 against 15·8 in the control and deserves a further trial on grounds of economy. In a somewhat similar series of tests in the control of smut on the hull-less Liberty oats, which are liable to a serious reduction of germination when treated with formalin, copper carbonate alone gave fairly satisfactory results (1 per cent. against 7·5 in the control) but the addition of talc, lime, or infusorial earth reduced its effectiveness (6·3, 5·6, and 6·9 per cent. smut respectively). Seed-o-San, chlorophol, and the 'Gas Grain Pickler' method did not give very encouraging results, the last-named causing injury to germination.

ANDERSON (P. J.) & OSMUN (A. V.). **An improved formaldehyde tank for the Onion drill.**—*Phytopath.*, xiii, 4, pp. 161–168, 3 figs., 1923.

In this paper the authors describe in detail a tank attachment for an onion seeding machine which will deliver formalin at a constant and any desired rate for the control of onion smut [*Urocystis cepulae*]. In all the types used at present, the rate of delivery varies according to the head of liquid in the tank and this has been surmounted by making the tank air-tight and placing the air inlet at the bottom of the tank in close position to the outlet for the liquid. The rate is regulated by the size of the hole in a disk inserted in the outflow pipe.

YOUNG (H. C.). **The toxic property of sulphur.**—*Ann. Missouri Bot. Gard.*, ix, 4, pp. 403–433, 4 diag., 1922. [Rec'd, 1923.]

In this work the author has attempted to determine the exact nature of the fungicidal property of sulphur. After a brief account of the history of sulphur sprays and references to the work of previous investigators, he describes a series of experiments carried out to ascertain the degree of toxicity to *Colletotrichum gossypii*, *Sclerotinia cinerea*, *Botrytis cinerea*, *Glomerella cingulata*, *Gloeosporium venetum*, *Macrosporium sarcinaeforme*, *Phomopsis sojae*, and *Actinomyces scabies*, of flowers of sulphur (ordinary and finely ground), colloidal sulphur, lime-sulphur, and the volatile products of sulphur. The Van Tieghem cell and the hanging-drop culture method were employed. The culture solution was a slightly buffered mixture containing mannite, phosphoric acid, and sodium hydroxide.

Flowers of sulphur were found to be directly toxic only to *Sclerotinia cinerea* and *Phomopsis sojae*. The spores of the remaining organisms germinated and the germ-tubes grew normally when in direct contact with the sulphur particles. The general fungicidal value of flowers of sulphur, if it exists, must be due to some change in form which takes place under different conditions from those obtaining in Van Tieghem cells. Within the usual range, the hydrogen-ion concentration did not appreciably influence the percentage of germination. Finely ground flowers of sulphur were found to be more toxic than unground sulphur, the range of greatest toxicity being between P_H 4·2 and 5·4.

Colloidal sulphur exists in two forms, termed by the author hydrophilic and hydrophobic respectively, depending on the degree of hydration. The hydrophilic form has a high degree of hydration and is identical with the 'soluble colloidal sulphur' of Raffo and Mancini (*Koll. Zeitschr.*, 9, pp. 58–61, 1911) and may be prepared by adding a saturated solution of sodium thiosulphate to concentrated sulphuric acid very slowly, repeated cooling, warming, and standing, and finally filtering until no more insoluble sulphur comes down, the final filtrate being the slight turbid yellowish solution which is subsequently purified. The hydrophobic colloidal sulphur has a very low degree of hydration and is identical with that prepared by V. Weimarn and Molyschew (*Koll. Zeitschr.*, 8, p. 214, 1911) and is the 'milk of sulphur' formed when sulphur is precipitated. Full details of the preparation of these substances used in the following experiments are given.

The toxicity of the hydrophilic and hydrophobic colloidal solutions was tested, in hanging drop cultures, omitting, however, *Glomerella cingulata* and *Actinomyces scabies*. The hydrophilic form proved extremely toxic, only *Botrytis cinerea* and *Macrosporium sarcinaeforme* offering a slight resistance to a dilute suspension. In stronger suspensions the germination of all the organisms was inhibited. The hydrophobic solution, however, only exerted approximately the same slight toxic action as ground flowers of sulphur. The influence of the hydrogen-ion concentration, especially on hydrophilic colloidal sulphur, was very striking, 'settling out' increasing rapidly as soon as the P_H value exceeded 5·4.

Lime-sulphur is extremely alkaline and its initial efficiency as a fungicide may be partly due to free hydroxyl ions. Tests were made of the P_H value of washings from sprayed surfaces exposed to various drying conditions and it was found all gave a final reaction of P_H 6·4, indicating that the protracted efficiency of lime-sulphur is not due to its causticity. The toxicity of the individual compounds of exposed or changed lime-sulphur (precipitated sulphur, calcium thiosulphate, calcium sulphite and calcium sulphate) was next determined, and the lasting fungicidal value of lime-sulphur found to be due almost entirely to the precipitated sulphur. The toxicity of lime-sulphur was somewhat greater than that of hydrophobic colloidal sulphur, but less than that of hydrophilic colloidal sulphur. The hydrogen-ion concentration influenced the toxicity in a similar manner as recorded above. A table is given showing the germinations of the various fungi, with the various forms of sulphur at ten different P_H values.

To determine the degree of toxicity of the volatile products of sulphur (the foregoing results having indicated that sulphur is most toxic in a finely divided state), an experiment was arranged in which the action of the vapours of flowers of sulphur, and of hydrophilic and hydrophobic colloidal sulphur on *Botrytis cinerea*, *Colletotrichum gossypii*, and *Sclerotinia cinerea* was tested. The spores were placed in drops of the slightly buffered solution without sulphur, the sulphur suspensions being placed at the bottom of the Van Tieghem cells. In this way the spores were separated from the sulphur by a distance of 8 mm. The cultures were incubated at 22° C. The flowers of sulphur exercised no toxic action even on

the sensitive *S. cinerea* and the hydrophobic colloidal sulphur was only slightly toxic to *B. cinerea* and *C. gossypii*. As in the previous tests the hydrophilic colloidal sulphur exhibited the usual degree of toxicity, especially at concentrations of P_H 4·0 to 5·5. Having determined that the toxic substance is volatile it was thought necessary to eliminate hydrogen sulphide, and sulphur dioxide and trioxide as possible toxic factors. A saturated solution of hydrogen sulphide did not inhibit germination and no toxicity could be noted with sulphur dioxide, in a concentration sufficient to kill when converted into hydrophilic colloidal sulphur by the addition of hydrogen sulphide. Sulphuric acid inhibited growth only in proportion to its acidity. Positive tests for sulphur dioxide and trioxide could not be obtained in aerated sulphur suspensions toxic to *S. cinerea*. These compounds, therefore, do not contribute to the toxic properties of sulphur.

In all the above experiments, the only oxygen available was that present in the closed rings, and an experiment was therefore conducted to determine the effect of unlimited oxygen in increasing the toxicity of flowers of sulphur and precipitated sulphur (hydrophobic colloidal sulphur) using Petri dishes in comparison with closed rings. The germination of *S. cinerea* and *C. gossypii* was found to be much greater in the latter experiments, and the tests proved conclusively that the toxic property of sulphur is due to an oxidation product, and that finely divided sulphur is more readily oxidized at ordinary temperatures than the ordinary sublimed sulphur. Tests in non-air tight cells, with *S. cinerea*, using dry hydrophobic sulphur and the suspension respectively, showed no inhibition of germination with the former. Oxygen and water are therefore necessary factors in the formation of the toxic volatile compound of sulphur.

The results of all the above experiments indicate that hydrophilic colloidal sulphur contains the toxic substance produced by the ordinary forms of sulphur. Having eliminated the more common oxides and acids of sulphur it was thought that the toxic compound may be one of the polythionic acids. It was found that hydrophilic colloidal sulphur not only contains such an acid but that the method employed in the preparation of the former for these experiments was practically identical with that employed for pentathionic acid.

The author tested the toxicity of this substance by freeing a hydrophilic colloidal sulphur solution from it, and it was found that the killing power (using *Botrytis cinerea* and *Colletotrichum gossypii*) was directly proportional to the amount of pentathionic acid present. The fact (ascertained by experiment) that the latter substance is an oxidation product of sulphur at ordinary temperatures, and also that it is volatile, an active absorption compound, and that it is unstable when in acid and alkali solutions, are held to support the view that it is the substance on which the toxicity of sulphur depends.

The study of the practical applications of the above data is not yet complete. A sulphur compound which will retain its fungicidal properties regardless of climatic factors is being sought. The material must readily yield pentathionic acid. The reaction must

be kept slightly acid (P_H 4·0 to 5·5) as the toxic compound is destroyed above or below this point. The solution must be readily oxidizable at ordinary temperatures, very adhesive, and not injurious to foliage. Colloidal sulphur combines all these properties when tested in the laboratory and greenhouse, and methods for its preparation in a form suitable for fungicidal use are being tested. Hydrophilic colloidal sulphur appears to be adapted for use as a spray and is not too expensive for practical purposes.

The practical application of the methods devised by various investigators for the preparation of colloidal sulphur are briefly discussed and a bibliography of sixty titles is appended.

RUBAN (G.). **Le permanganate de potasse : agent de traitement de maladies de la Vigne.** [Permanganate of potassium: a method for the control of Vine diseases.] *Rev. de Vitic.*, lviii, 1502, pp. 269–272, 1923.

Excellent results have been obtained in the control of vine mildew (*Oidium*) by washing the stems in winter with a solution of potassium permanganate (300 to 350 gm. per hl. of water).

The permanganate, which must be thoroughly dissolved, is usually curative rather than preventive in its action, destroying the spores of the fungus when they are actually present but not retaining its efficacy more than a few hours. Its adhesiveness may be increased by the addition of lime at the rate of 3 kg. per hl. of the solution.

In the case of varieties which cannot tolerate sulphur—e.g. Othello—the use of the permanganate is practically indispensable.

CHAN (T. A. B.). **Ueber die Mycorhiza der Buche.** [The mycorrhiza of the Beech.]—*Allg. Forst. und Jagdzeit.*, xcix, 2, pp. 25–31, 4 figs., 1923.

The isolation of the mycorrhizal fungus from the roots of beech trees [see also this *Review*, i, p. 304] from Munich and the Tyrol is described in considerable detail. The medium used was 1·5 per cent. agar in a mineral nutrient solution consisting of 1 gm. K_2HPO_4; 0·1 gm. $CaCl_2$; 0·1 gm. NaCl; 0·3 gm. $MgSO_4{,}7H_2O$; 0·005 gm. $FeSO_4$; 1000 gm. distilled water to which 0·25 per cent. of starch was added.

The fungus isolated was named *Mycelium radicis fagi*. The mycelium was septate, greenish in colour, the longer hyphae 4 to 6 μ and the shorter 2 to 4 μ in diameter. On plum and malt agar a luxuriant aerial mycelium was formed. In cultures three to four weeks old irregular conidia were formed by the constriction and dissolution of the long and short hyphae. The addition of one per cent. peptone to the medium resulted in the dissolution of all the hyphae into conidia resembling those of the orchid fungus. Clamp-connexions were absent and in transverse sections of the root the fungus presented a sclerotial appearance.

Of the various sources of carbon tested, saccharose, mannite, manna, dextrose, gum tragacanth, and arabinose promoted development; amygdalin, aesculin, cacao-butter, and lactose were intermediate; while starch, maltose, asparagin, nucleic acid, malic acid, formic acid, and tartaric acid were unfavourable, these results indicating the probable presence of emulsins. Growth was entirely

inhibited on benzoic acid and urea, and also by concentrations of tannin exceeding 0·05 per cent.

Further investigations are in progress.

TITS (D.). **Les excitants de la germination d'un champignon: Phycomyces nitens.** [The stimulants to the germination of a fungus: *Phycomyces nitens.*]—*Bull. Cl. Sci. Acad. Roy. de Belgique*, Sér. 5, viii, 5, pp. 219–227, 4 figs., 1922.

Before commencing his study on the stimulation of germination of fungi preliminary tests were made by the author, using *Phycomyces nitens*, to determine the optimum temperature for germination and the development of the first sporangia of this fungus. Each of a series of tubes containing fresh white bread and prune juice was inoculated with a five days old sporangium and the tubes incubated at various temperatures. One series of tubes was artificially illuminated day and night, while another similar series was maintained in total darkness. The best culture in the illuminated series was obtained at a temperature of approximately 22° C., the tubes incubated at 19°, 23°, and 27° giving markedly inferior growth. Corresponding results were obtained from the tubes kept in the dark, a notable feature of which, however, was the larger size of the sporangiophores.

The effect of various substances on the germination of the spores at 22° C. was then investigated. The spores failed to germinate in solutions of 0·5 to 5 per cent. glucose, saccharose, lactose, and raffinose with and without the addition of various nitrogenous substances (asparagin, leucine, ptyaline, pepsine, and glycocol) and tartaric acid at varying concentrations. With 1 per cent. of peptone, however, germination was secured in less than 24 hours. The process of germination is described and figured. The maximum concentration of peptone compatible with germination is 30 per cent., whilst in solutions from 0·7 to 0·9 per cent. the spores germinated but their appearance was abnormal. The addition of saccharose to the medium reduces the quantity of peptone necessary to ensure germination; thus in a solution of 100,000 parts of water, 8 parts of peptone, and 700 parts of saccharose, the results are equivalent to those obtained in a solution of 100,000 parts of water and 700 parts of peptone.

Bacteriological peptone is composed of an aggregate of amino acids, and is obtained by the hydrolysis of meat albumin in the presence of tartaric acid. In the sample used the presence of tryptophane, tyrosine, phenylaniline, and cystine was detected.

Further studies on the action of amino acids in the germination of *P. nitens* are in progress.

WEIMER (J. L.) & HARTER (L. L.). **Influence of temperature on the pectinase production of different species of Rhizopus.**—*Amer. Journ. of Botany*, x, 3, pp. 127–132, 1923.

In view of the relationship found to exist between the different species of *Rhizopus* with respect to the temperatures at which they cause rots [see this *Review*, i, p. 433], experiments were undertaken to ascertain the influence of temperature on pectinase production in *Rhizopus nigricans, reflexus, delemar, oryzae, nodosus, tritici,*

maidis (all parasitic on sweet potato), *microsporus*, and *chinensis*. The amount of the enzyme was estimated by the maceration of disks of sweet potato in solutions from cultures or in water suspensions of pulverized mycelium. A table showing the average rate of maceration for each of the eight species at 9°, 20°, 30°, and 40° C. is given. The amount of enzyme, both that exuded into the substratum and that retained in the mycelium, was least at the highest temperature. The quantity of enzyme in the mycelium was found to increase with a decrease in the temperature down to and including 9° C. Similar results were obtained from the solution except for a slight reduction in the quantity of enzyme produced when the temperature was lowered from 20° to 9° C. The non-parasitic species produced a considerable quantity of enzyme, while the parasitic *R. nigricans* manufactured only a very small amount.

A comparison was made of the relative length of time required by the enzyme produced by the different species to macerate the tissue of freshly dug sweet potatoes and those held in storage for several months. The fungi were grown at 9°, 30°, and 40° C., maceration being carried out at the last-named temperature. It was found that, in general, the middle lamellae of old potatoes were dissolved in about half the time required to macerate the tissue of new ones.

PARTRIDGE (G.). **Potato inspection and certification in Canada, 1922.**—*Agric. Gaz. of Canada*, x, 2, pp. 121-123, 1923.

The head-quarters of the Canadian potato inspection service are at the Central Experimental Farm, Ottawa, the service being under the direction of the Dominion Botanist, Dr. Güssow, with the writer in immediate charge. The work of the service, which began on a small scale in 1915, now extends throughout the Dominion. It is organized by provinces, a supervisor in each province being responsible to head-quarters for the work of the permanent and temporary inspectors employed by the service. British Columbia maintains a provincial service conforming, however, to Dominion standards.

During 1922, a total of 3,283 fields, comprising 11,250 acres, was inspected, the average amounts of disease in the fields accepted for certification being as follows: blackleg [*Bacillus atrosepticus*] 0·47 per cent., leaf roll 0·65 per cent., mosaic 1·06 per cent., and wilts [*Fusarium oxysporum* or *Verticillium albo-atrum*] 0·14 per cent.

As a result of the experience gained during the past years, definite and permanent field inspection standards have been decided upon, and will take effect from next season. The standard adopted is as follows: blackleg 3 per cent., leaf roll (including curly dwarf, crinkle, spindling sprout, and streak) 2 per cent., and wilts 3 per cent., provided that in no case shall a total of more than 6 per cent. be allowed.

The following are the standards for tuber inspection: bacterial rot [various bacteria] or wilt 2 per cent.: late blight [*Phytophthora infestans*] and dry rot [*Fusarium oxysporum*] 3 per cent.: common scab [*Actinomyces scabies*] and severe *Rhizoctonia* 5 per cent.; powdery scab [*Spongospora subterranea*] 1 per cent.

ROSA (J. T., JR.). **Note on an indirect effect of spraying Potatoes with Bordeaux mixture.**—*Amer. Journ. of Bot.*, x, 3, pp. 113–116, 2 figs., 1923.

A spraying experiment conducted at Columbia, Missouri, during 1921 indicated that the application to Irish potatoes of Bordeaux mixture or other preparations tending to increase the yield and prolong the period of vegetation may, under certain conditions, be accompanied by undesirable results.

Early Ohio potatoes were given four applications of 4–4–50 Bordeaux, with and without arsenate of lead and nicotine sulphate, the sprayed plants remained green three weeks longer, and gave an average yield 34·2 per cent. higher than the controls. In the absence of early and late blight [*Alternaria solani* and *Phytophthora infestans*], these results must be ascribed to the control of tipburn and hopperburn. The tubers from the sprayed plots, however, consisted largely of knobby second growths, so that the actual quantity of marketable potatoes was much less than from the control plots, which showed second growth only to a moderate extent. The knobby growths appeared to be produced during periods of favourable weather, at the tips of previously formed tubers, 4 or 5 growth zones sometimes being identified.

The writer thinks that sharp fluctuations in the soil-moisture content, such as accompany rapidly alternating meteorological conditions, may be largely responsible for the phenomenon of second growth, especially on the Early Ohio variety. Salaman has shown (*Journ. Min. Agric.*, xxviii, p. 43, 1921) that the tendency to produce second growth is not transmissible, and that knobby second growths planted as seed pieces gave a larger yield than pieces from normal tubers. Hence there is no reason to regard such tubers as physiologically defective. It is hoped that further investigations will throw light on the relation of soil-moisture variations and other edaphic factors to tuberization.

RAMBOUSEK (F.). **Rübenschädlinge und Krankheiten im Jahre 1921.** [Beet pests and diseases in the year 1921.]—*Zeitschr. für Zuckerind.*, [Prague], xlvii, 24, pp. 324–329, 1923.

The author gives an account of the diseases of [sugar] beet occurring in Czecko-Slovakia during 1921. Root rot was reported during the spring from a good many localities. In many cases, however, the disease was not due to *Phoma betae* but to the type of soil on which the plants were grown. The seedlings are unable to force their way to the surface of heavily encrusted soils without undue pressure and consequently they gradually decay. In order to ascertain whether a plant is affected by the physiological disorder or by *P. betae*, the constricted and decayed portion of the hypocotyl should be examined. A black discoloration denotes infection by the fungus and a brown discoloration the non-parasitic injury.

Chronic root rot was reported from one district in the middle of July, and bacteriosis and chlorosis also occurred. Scab [*Actinomyces scabies*] was reported from two localities; it is most prevalent on acid soils. Heart rot (*Phoma betae*) occurred fairly extensively. It is frequently confused with the cavities under the heart produced

by intensive growth, and may best be recognized by the black discoloration of the inner leaves. *Rhizoctonia violacea* occurred principally on beet following clover.

BOURNE (B. A.). **Researches on the root disease of Sugar-cane.**—*Dept. of Agric. Barbados*, 17 pp., 5 pl., 1922. [1923.]

Root disease of sugar-cane [see this *Review*, i, pp. 102 and 270] is of greater economic importance in Barbados at present than any other fungous disease or insect pest. The present paper is the outcome of protracted research on the possible factors governing the incidence of the disease in that island. The author points out the confusion existing with regard to root disease and has been careful to limit his investigations to 'decomposition of roots taking place on account of the invasion of fungi'.

Numerous isolations which are described in detail were made from typically affected canes. The first plantation to be investigated yielded a species of *Rhizoctonia* closely resembling *R. solani*. From another plantation a species of *Rhizoctonia* nearly allied to *R. pallida* Matz was recovered in pure culture, whilst from a third plantation in 1921 *R. solani* was again isolated a number of times, but in addition a species of *Fusarium* occurred, this being thought to be the first record of *Fusarium* sp. in connexion with the root disease of sugar-cane. It was observed that neither *Marasmius sacchari* nor *Trichoderma lignorum*, both of which were repeatedly recovered from dead cane roots, was isolated from freshly diseased material. Further isolations showed that either *R. solani* or *R. pallida*, with or without *Fusarium* sp., *T. lignorum*, or *M. sacchari*, was associated in every case with a dirty reddish discoloration of the internal tissues of the basal portion of the stems.

The various fields affected by root disease were observed to show a complete absence of the trash generally used in the covering of young plant canes, resulting in a very high temperature of the soil. This has been shown by Peltier (*Illinois Agric. Exper. Stat. Bull.* 189, 1916) to be correlated with the maximum virulence of attack by *R. solani*. The age of the affected plants varied from first to fourth ratoons, and whilst root disease is not restricted to any specific kind of soil, in every case a period of excessive drought preceded the first report of the disease.

The results of inoculation experiments, details of which are given, proved conclusively that both *R. solani* and *R. pallida* are parasitic on the sugar-cane and capable of producing the typical symptoms of root disease. Control plants maintained under the same conditions showed no signs of disease, whilst inoculation experiments with *M. sacchari* and *Fusarium* sp. gave negative results.

The reaction of the medium between $-15°$ and $+30°$ Fuller's scale has no effect on the growth of *R. solani* [see also this *Review*, ii, p. 419], but *R. pallida* develops best between $+25°$ and $+30°$ Fuller's scale, with comparatively good growth between 5° and 20° and fair growth between $-15°$ and 0°. The best growth of both fungi was obtained on *Diaprepes* grub agar, glucose and glycerine peptone beef agar, sweet potato agar, and cornmeal agar.

During the examination of the basal portions of an infected stool a typical rot of the fibro-vascular bundles resembling that described

by Matz as due to *Plasmodiophora vascularum* [see this *Review*, i, p. 314] was noticed. A histological investigation of sections of the diseased material revealed the presence of very active, ciliate, protozoan organisms. The numerous encysted forms of these protozoa bore a striking resemblance to the spherical, smooth, or coarsely granulated spores with thick, hyaline walls described by Matz. After several days the cysts turned from hyaline to orange-yellow or brownish. Their diameter, when mature, varied from 13·5 to 16 μ, occasionally 8 to 19 μ. As in the case of *P. vascularum* germination was never observed. The adventitious roots of the stool in question and others from which the organism was isolated were all infested by one or other of the root-destroying fungi. A full description of the protozoan organism, which is stated to grow well on potato agar, sterilized cane stem and cane juice, is appended.

HIND (R. R.). **Toledo Cane: a mosaic-immune variety.**—*Sugar Central and Planters' News*, iv, 3, pp. 105–107, and 110; 5 figs. 1923.

Dr. E. W. Brandes has discovered that a variety of sugar-cane growing on the estate of Señor Toledo, Del Carmen, Pampanga [Luzon, Philippine Islands], is immune from mosaic disease. The variety, in appearance and size, greatly resembles D–1135, being erect in habit, thick in growth, and with longer internodes than are usually found in local canes. The rind is tough, purple in colour, and the pith yellowish; the leaves are dark green, narrow, and quite straight. The leaf sheaths adhere tenaciously to the stalk even when dead, forming a protective covering which may partially explain the complete absence of attack by the maize aphis [*Aphis maidis*]. Some idea of the luxuriant growth and prolific yield of the Toledo variety may be given by the statement that from six stools cut for seed in December 1920 there are now seven hectares of cane. Some stools of ratoons produced forty-two stalks, the latter rarely exceeding 1¼ in. in diameter.

In view of the prevalence of mosaic disease of sugar-cane in the Philippines, the discovery of an apparently immune variety is of considerable interest.

WILBRINK (G.). **Warmwaterbehandeling van stekken als geneesmiddel tegen de serehziekte van het Suikerriet.** [Hot water treatment of setts as a remedy for the sereh disease of Sugar-cane.]—*Meded. Proefstat. Java Suikerind.*, 1, 15 pp., 1923.

In July 1921 a series of experiments was carried out at Cheribon [Java] to test the effects of hot water treatment on sugar-cane setts affected by sereh disease. A preliminary test with healthy EK 28 setts indicated that 30 minutes' immersion in water heated to a temperature of 52° to 55° C. was not injurious to germination in that particular variety. For comparative purposes a test was also made with Black Cheribon setts suffering from gummosis. It was found that the hot water treatment almost completely inhibited germination in this case, so that the possibility of controlling the latter disease on these lines appears very slight. Setts affected with gummosis are destroyed at lower temperatures than healthy ones,

which may facilitate the selection of sound setts for planting, but this has not yet been fully investigated.

The results of the experiments with Black Cheribon and White Preanger setts affected by sereh disease may be summarized as follows. The immersion of Black Cheribon setts in water heated to a temperature of 52° to 55° C. for 30 minutes somewhat impaired germination but absolutely controlled the disease. The general condition of the crop was excellent. Immersion at the same temperature for 15 minutes gave slightly less satisfactory results both as regards freedom from the disease and general vigour. The untreated controls were nearly all diseased.

The germination of White Preanger setts was not impaired by immersion at 50° to 55° C. for 30 minutes, but complete control was also not obtained. Some of the setts were planted in February 1922 after 30 minutes' immersion at 45° C. and another 30 minutes at 50° to 52° C., with excellent results. The idea of preliminary heating was suggested by the author's discovery that some 15 minutes elapse before the interiors of moderately thick setts reach the temperature of 52°. Immersion at a temperature of 48° to 50°, even after a preliminary heating, gave less satisfactory results. Further tests in February 1922 with the EK 28 variety confirmed the previous results. The outcome of a few preliminary tests indicates that the method is suitable also for the control of the root rot fungus [? *Marasmius sacchari*], but not for that of stripe disease [mosaic].

The fact that sereh disease can be controlled by the exposure of the affected setts to a certain temperature strongly suggests that it is caused by a parasitic organism, the thermal death point of which lies between 50° and 55° C. Further investigations will be necessary to ascertain the nature of the organism involved, but in the meantime the theory that sereh disease belongs to the 'degeneration' group appears to be definitely disposed of. Mosaic and allied diseases are known to thrive at considerably higher temperatures than that which destroys the sereh organism.

On account of the possible reduction of germination it is not at present advisable to recommend the hot water treatment on a large scale. It is believed, however, that a method can be devised whereby the injury to germination is eliminated. In the meantime the practice of the hot water treatment on a small scale, particularly in experimental stations and the like, can safely be recommended.

Lee (H. A.). **Sereh disease of Sugar-cane in Singapore.**—*Phytopath.*, xiii, 3, p. 145, 1923.

In 1922 whilst at Singapore Botanic Gardens the writer found sugar-cane affected with the typical symptoms of the sereh disease of Java. The canes had been imported from Java. He calls attention to the risk of sereh, Fiji disease, downy mildew [*Sclerospora*] and cane smut [*Ustilago sacchari*] diseases being transmitted on canes imported from oriental countries into the western hemisphere where these diseases are unknown or at least not general.

MÜLLER (K. O.). **Ueber die Beziehungen von Moniliopsis aderholdi zu Rhizoctonia solani.** [On the relations between *Moniliopsis aderholdi* and *Rhizoctonia solani*.]—*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, xi, 4, pp. 321–325, 1 fig., 2 diag., 1923.

Several investigators, references to whose work are given, have endeavoured to throw light on the systematic position of the so-called 'propagation fungus' ('Vermehrungspilz'), which causes considerable damage in seed-beds. The fungus, which has been referred to a variety of genera, including *Mortierella*, *Botrytis*, and *Sclerotinia*, was later named *Moniliopsis aderholdi* by Ruhland (*Arb. Biol. Reichsanst. für Land- und Forstwirtsch.*, 6, pp. 71–76, 1908), and more recently it has been identified by Duggar (*Ann. Missouri Bot. Gard.*, iii, p. 1, 1916) with *Rhizoctonia solani* or its basidial stage *Corticium vagum* var. *solani*.

The results of comparative cultural experiments, the technique of which is fully described, with strains of *Moniliopsis aderholdi* (identical with authentic cultures of this fungus) from cyclamen leaves and of *R. solani* from potato roots revealed a number of differences between the two fungi. The maximum, minimum, and optimum temperatures for the growth of the mycelium of *M. aderholdi* were 31·8° to 35°, 14°, and 29° [C.] respectively, the corresponding temperatures for mycelial growth of *R. solani* being slightly over 30°, 7°, and 25° [C.]. Morphological differences were also noticed. The mycelial texture of *M. aderholdi*, especially at the higher temperatures, was finer than that of *R. solani*, the average diameters of the hyphae being 7 μ and 8·3 μ respectively.

In order to test the influence of osmotic concentration and the chemical reaction of the medium on the development of the mycelia, varying concentrations of the Van 't Hoff salt mixture (100 Mol NaCl, 2 Mol $CaCl_2$, 2·2 Mol KCl, and 7·8 Mol $MgCl_2$) were added to the potato leaf agar. The cultures were incubated at a temperature of 26·5° [C.]. The initial concentration p was 4 per cent. NaCl and the corresponding mixtures of the other salts. Marked differences in the reaction of the two fungi were perceptible. Whereas the *Rhizoctonia* cultures developed normally at and beyond the concentration $p/2$, those of *Moniliopsis* made only feeble and irregular growth at the same concentration. At p the development of *Moniliopsis* was virtually inhibited. In general, the mycelium of *Moniliopsis* was denser than that of *Rhizoctonia*. At the higher concentrations *Moniliopsis* showed a much stronger tendency to develop involution forms than *Rhizoctonia*. At $p/4$ abnormal formation of the hyphae of *M. aderholdi* were frequent, and at $3p/4$ there was hardly a normally shaped hypha to be seen. In *R. solani*, on the other hand, only isolated irregularities of hyphae formation were observed, even at the highest concentrations.

Fragments of *M. aderholdi* grew in liquid cultures at acid concentrations which inhibited the mycelial growth of *R. solani*. The optimum acid concentration for the development of *M. aderholdi* was $p/2$, and for that of *R. solani* $p/1$. The hyphae of *R. solani* in liquid cultures gradually wove themselves into a firm, membranous, mycelial weft; while those of *M. aderholdi* developed in coils and finally formed a more or less spherical mycelium.

Inoculation experiments with *M. aderholdi* on thirty potato tubers previously disinfected with formalin resulted in the formation, close to the point of inoculation, of isolated, dark brown, sclerotial bodies, resembling those described by Ruhland as 'pseudosclerotia'. No injury to the young shoots was observed, and the hyphal network on the roots and underground portions of the stem, which is typical of *Rhizoctonia* infection, was entirely absent. Parallel tests with *Rhizoctonia* cultures gave positive results both on tubers and shoots, all the well-known symptoms of infection being present.

It is apparent from the above investigations that *M. aderholdi* cannot be regarded as identical with *R. solani*, and that, for the present, the systematic position of the former remains obscure. The fact that *M. aderholdi* can only flourish at temperatures between 14° and 35° C. explains its incidence at medium and high temperatures in greenhouses and seed-beds.

MÜLLER (K. O.). **Ueber die Beziehungen zwischen Rhizoctonia solani Kühn und Hypochnus solani Prill. et Del.** [On the relations between *Rhizoctonia solani* Kühn and *Hypochnus solani* Prill. & Del.]—*Arb. Biol. Reichsanst. für Land. und Forstwirtsch.*, xi. 4, pp. 326–330, 1 fig., 1923.

After a brief review of the work of Rolfs and other investigators on the connexion between *Rhizoctonia solani* and *Hypochnus solani* Prill. et Del. (*Corticium vagum* B. & C.), the author describes his own experiments in the same field.

In September 1922 a number of flower-pots were half filled with sterilized soil and in each two tubers, previously disinfected with formalin, were planted on the surface of the soil. Fragments of potato stems attacked by *Hypochnus* mycelium were attached to the under side of the glass panes covering the pots, so that the spores from these fragments fell on to the tubers. After 36 hours the tubers were covered with sterile soil and placed in the greenhouse. By December, 60 per cent. of the seedlings from the inoculated tubers showed the typical symptoms of infection by *Rhizoctonia*. The underground portions of the young shoots were covered with brown hyphae and a partial disintegration and brown discoloration of the epidermis was observed. The uninoculated control tubers remained healthy. *Hypochnus* spores therefore are capable of producing the typical *Rhizoctonia* disease, and further experiments showed that mycelium developed from *Hypochnus* spores (which was identical in all respects with that obtained from *Rhizoctonia*) also behaved similarly.

The results of comparative cultural experiments also point to the identity of the two fungi. For all the *Hypochnus* strains the maximum temperature for growth was about 30° [C.], the minimum between 5° and 7·3°, and the optimum about 23° [C.]. These figures agree closely with the temperature relations of *R. solani* [see preceding abstract]. There were, however, discrepancies in some of the strains which seem to indicate that the species *H. solani* includes a variety of biological forms. Thus two strains grew less rapidly than the others, their mycelia being correspondingly sparse. The virulence of the strains also varied considerably. Apart from

negligible divergences, the reaction of *H. solani* to the osmotic concentration and to the acidity or alkalinity of the medium approximated to that of *R. solani* [see preceding abstract].

In order to produce the fructifications of *Rhizoctonia*, four tubers artificially inoculated with *Rhizoctonia* were placed in each of seven flower-pots in the greenhouse. At the time of flowering four of the resulting plants were covered with the typical *Hypochnus* mycelium at the base of the stem. Similar tests were conducted in the field, 150 tubers being inoculated with *Rhizoctonia* and a further 150 serving as controls. It was impossible entirely to preclude natural infection by *H. solani*, however, the control plants giving 17 per cent. infection whilst those artificially inoculated gave 38.

The basidial stage of *Rhizoctonia* was also obtained in pure culture in Erlenmeyer flasks filled with 50 cc. of a solution containing 1 per cent. Witte peptone and 0·5 per cent. potato starch. Within 17 days the mycelium was sufficiently developed to be transferred, after washing, to tubes containing filter paper saturated with water, maintained at a temperature of 20° to 21° [C.]. The mycelium developed aerial hyphae, and on the fifth day basidia were detected in two of the cultures. The measurements of the basidia averaged 9·5 by 5·7 μ and thus agreed with those obtained by Saccardo. The sterigmata appear to be somewhat smaller than those figured in Engler's 'Natürlichen Pflanzenfamilien' (i, 1, p. 115, 1900). Such a minor discrepancy, however, is probably due to the action of certain external factors on the cultures, and do not invalidate the conclusions mentioned above.

MAINS (E. B.). **Evidence of the seed carriage of the Euphorbia rusts, Uromyces proeminens and U. dictosperma.**—*Proc. Indiana Acad. Sci., 1921*, pp. 137–139, 1922. [Rec'd 1923.]

The author describes his experiments relating to the seed transmission of *Uromyces proeminens*, occurring on *Euphorbia dentata* and *E. preslii*, in the vicinity of Lafayette, Indiana, and *U. dictosperma* occurring on *E. arkansana* and other species in the western States. He also presents additional facts relating to the identity of the systemic aecidia on the latter hosts with *U. dictosperma* and to the production of uredospores in the life-cycle of this fungus.

In the autumn of 1920 seed was collected from plants of *E. dentata* heavily rusted with the teleutospores of *U. proeminens*. The seed was sown on 22nd January [1921] and the first symptoms of infection were observed on 1st March, when pycnidia appeared on one capsule of one plant. Subsequently other plants developed pycnidia or aecidia, or both. A brief discussion of the symptoms on each affected plant is given.

Seed from plants of *E. arkansana* heavily infested with teleutospores of *U. dictosperma* was collected in July 1920 and planted in the following August. On 12th November one branch of one plant became infected and died. After this all the plants remained healthy till March [1921] when eleven of the forty-two plants showed infection by aecidia or pycnidia, or both. Later uredo- and teleutospores appeared on most of the plants, presumably from

aecidial infection. The branches infected with aecidia died without setting seed and the plants finally showed only teleutospores.

Aecidia from the above-described material were sown on healthy plants and produced uredospores, which were, however, soon replaced by the characteristic teleutospores of *U. dictosperma*. It is evident therefore that the systemic aecidia found on *E. arkansana* represent the aecidial stage of *U. dictosperma*. The subsequent production by these aecida of uredo- and teleutospores denotes that *U. dictosperma* is a full-cycled, autoecious species.

The above evidence is considered sufficient to prove that these two rusts are seed borne. The manner of their dissemination will form the subject of further investigations.

PETCH (T.). **Black rot of tea.**—*Trop. Agric.*, lx, 2, pp. 89-90, 1923.

During the last year a comparative examination has been made of thread blights on various plants from Java, India, Ceylon, the West Indies, and West Africa. An examination of the Java and Sumatra specimens proved conclusively that the species of *Corticium* causing black rot of tea in Ceylon is not *C. theae*. The latter is a true thread blight, forming a definite white cord running along the stem of the host plant. On the other hand, the mycelium of each of the Ceylon black rot fungi runs along the stem in a very thin, hyaline film which is invisible to the naked eye unless in the act of producing a fructification.

Recent investigations indicate that there are at least two species of *Corticium* causing black rot in Ceylon. One of these occurs on tea, *Oxyanthus tubiflorus*, *Calophyllum burmanni*, and *Hemidesmus indicus*, and will probably be found to be a general parasite on jungle shrubs. The other occurs on coca (*Erythroxylon coca*), but owing to the difficulty of obtaining mature fructifications it is not easy to distinguish one species from another.

Black rot of tea was originally discovered in the low country, but has since been found at an elevation of nearly 6,000 ft. Its distribution, therefore, is probably general.

PETCH (T.). **Cercosporella leaf disease.**—*Trop. Agric.*, lx, 2, pp. 87-89, 1 pl., 1923.

The symptoms and distribution of the leaf disease of tea, caused by *Cercosporella theae*, are described. The essential features of the disease have already been reported [see this *Review*, i, p. 331, and ii, p. 294]. A plate shows affected leaves and a typical spore of the parasite.

WOLF (F. A.). **Wildfire of Tobacco.**—*North Carolina Agric. Exper. Stat. Bull.* 246, 26 pp., 7 figs., 1922.

In North Carolina wildfire of tobacco, caused by *Bacterium tabacum*, makes its first appearance in the seed-beds during the last week of April or beginning of May. A wet rot stage not previously described by the present writer occurs on the smallest plants, the leaves of which are often completely rotted, whereas in other cases the infected tissues wither and fall away. A water-soaked zone divides the healthy from the diseased tissues. The

bud leaves of affected plants are pale, erect, and slow to develop, and the plants may perish in the seed-bed or not survive transplantation. The areas affected are usually on the lowest and dampest portions of the beds.

Observations in North Carolina, extending over a considerable period, show that wildfire invariably originates in the seed-bed. This confirms the results obtained by other investigators in Virginia, Massachusetts, and Connecticut.

The remainder of the *Bulletin* deals with the effects of the disease, the results of experimental work, the factors governing the transmission of wildfire, and appropriate measures of control, notes on which have already been published from other sources [see also this *Review*, i, pp. 93, 94, and 376, and ii, p. 37].

TISDALE (W. B.). **Tobacco diseases in Gadsden County in 1922.**—*Florida Agric. Exper. Stat. Bull.* 166, pp. 77–118, 1922.

The following tobacco diseases occurring in Gadsden County [Florida] are described and figured, appropriate measures of control being recommended in each case.

Mosaic was not serious in 1922, as it appeared very late and affected chiefly the sucker leaves. Infected horse nettle [*Solanum carolinense*] and ground cherry [*Physalis*] plants are common in the tobacco fields of Gadsden County, and are believed to promote the spread of the disease. In both these plants the symptoms of the disease are much less conspicuous than in tobacco, and one species of ground cherry is said to act as a carrier of mosaic without itself showing any signs of infection. Mosaic may spread for a distance of several hundred feet among the weeds, and during the past season it was observed that mosaic was transmitted from plant to plant by labourers poisoning for budworm. Mosaic plants should be pulled out and the hands thoroughly washed before touching healthy plants. The eradication of weeds and covering the plant beds with cloth to prevent the transmission of the disease by plant lice and flea beetles are also recommended.

Wildfire, caused by *Bacterium tabacum*, was reported from Florida in 1921, but the diagnosis was regarded as somewhat uncertain. In 1922, however, the disease appeared in three two-acre fields, the source of infection being traced to two plant beds, one of which was covered with second-hand cloth from Connecticut. In all probability the germs were carried on this material. A description of this disease, together with suitable measures of control, has already been published [see this *Review*, ii, p. 37]. Granville wilt, caused by *Bacterium solanacearum*, appears to be decreasing in prevalence in Florida, and the attack in 1922 was extremely mild. The hope of developing strains of tobacco resistant to this disease has not been realized, but a method of shallow cultivation may be devised, which would reduce root injury and thereby lessen infection. All possible measures to localize the outbreak should be taken.

Leaf spot, due to *Phyllosticta nicotianae*, appears to be limited in distribution and of minor importance. No definite control measures can be recommended until more is known of the life-history of the causal organism, but observations made in 1922 suggest that

the injury may be reduced by sowing the seed thinner, or thinning the stand on the poorer spots of soil.

Root rot, caused by *Thielavia basicola*, was widespread in 1922; growers report that during average years the plants finally outgrow the disease and produce fairly good yields, the crop, however, being two to four weeks late in maturing. Attempts are in progress to develop strains of tobacco resistant to root rot, the most promising of which are Connecticut Round Tip and (according to Valleau and Kinney) White Burley [see this *Review*, ii, p. 37.]

Frog-eye or 'specking', caused by *Cercospora nicotianae*, was very prevalent in 1922. Very little damage was sustained by the crop in fields where the leaves could be primed early, but wherever this process was delayed by rain considerable losses were caused by the disease. Vigorous, rapidly growing plants appear resistant, the fungus attacking mainly those weakened by unfavourable weather and soil conditions; in 1922 a fortnight's rain in June appeared to be the predisposing factor. The following suggestions are made for control: (1) root rot predisposes to frog-eye and hence varieties resistant to it should be selected where root rot is prevalent; (2) deep cultivation late in the season should be avoided, as this tends to check the growth and thus causes premature ripening of the leaves.

'Black shank', which made its first appearance in the United States in 1915 in Decatur County, Georgia, is rapidly gaining a foothold in Gadsden County, where it was the most serious disease of tobacco in 1922. Big Cuba was the most resistant variety and Connecticut Round Tip and White Burley the most susceptible. Conspicuous symptoms of the disease, which only attacks tobacco, are damping-off of seedlings, a dry black rot of the basal portions of the stalks of older plants, and a sudden wilting of the leaves. The roots of such plants are partially or entirely decayed, with a brown or black discoloration, but plants with apparently healthy roots may show the typical lesions on the stalks. As a rule these appear on the stalk at soil level and advance in both directions. Mycelial hyphae are usually present in streaks of brown, woody tissue; the pith within the diseased area is dry and brown and usually split into plate-like disks.

The disease may also affect the leaves, stalk, petioles, or leaf-blade during damp, cloudy weather, producing large brown blotches varying from one to three inches in diameter. On the Big Cuba variety these blotches are circular and marked with concentric bands of different shades of brown, whilst those on Connecticut Round Tip and Wisconsin No. 1207 are dark brown and at first have the consistency of wet rot. In this condition the diseased plants resemble Irish potato plants suffering from late blight [*Phytophthora infestans*]. Conidiophores and conidia of the causal organism have been observed in small numbers in the leaf lesions during cloudy weather, accompanied in lesions a few days old by species of *Fusarium*. When priming takes place during damp weather as much as 20 per cent. of the leaves from infected fields may rapidly develop greenish blotches, mottled with brown, after being hung in the barn. No further development has been observed to occur in the packing house.

The specific organism has been isolated from typical 'black shank' plants and proved by inoculation experiments to be highly pathogenic to healthy tobacco plants. The morphology of this fungus corresponds closely with that of *Phytophthora nicotianae* de Haan, with which it is in all probability identical. The conidia are mostly ovoid and apiculate, 25 to 33 μ in diameter, olivaceous, with a granular content. They begin to germinate in distilled water in about 15 minutes, producing ten to twenty zoospores, oval or bean-shaped, about 6·5 μ in diameter, and then after 15 minutes they cease activity, enlarge, and apparently disintegrate.

A difference in resistance between individual plants and varieties appears to exist. Until more information regarding the disease is available, its spread should as far as possible be localized by appropriate measures which are given in detail.

VALLEAU (W. D.). **An important period in the life history of two bacterial organisms causing leaf-spots on Tobacco.**—*Phytopath.*, xiii, 3, pp. 140–144, 1 fig., 1923.

Angular leaf spot [*Bacterium angulatum*] and wildfire [*Bact. tabacum*] of tobacco have been shown by Fromme to be transmitted by the seed [see this *Review* i, p. 94, and ii, p. 244]. There is some evidence, however, that the organism of the former disease at least may live in the soil some considerable time and as a few infected plants in the field can start infection of large plantings, treatment is desired which will remove all traces of the disease in the seed-bed.

By adding sulphur at the rate of 500 lb., 1,000 lb., and 2,000 lb., per acre to trial plots in a greenhouse, the author controlled the disease completely although infected seed was used, whereas in untreated plots numerous infections occurred where the tips of the cotyledons curled back and touched the soil. The treatment, however, was disastrous to the young plants, which were reduced severely in numbers, and it cannot be recommended for practice. The work, however, is considered to indicate that soil infection occurs first and leaf infection follows and that complete control of the disease may be obtained by suitable applications of disinfectants to the soil.

Departmental Activities: Botany.—*Journ. Dept. Agric. S. Africa*, vi, 3, pp. 202–203, 1923.

Nicotiana rustica, which until recently was free from parasitic diseases in S. Africa, except the disease known as brown spot, caused by *Macrosporium longipes*, has now been reported from Vereeniging to be attacked by the root parasite *Striga orobanchoides*. In all probability this plant's life-cycle is similar to that of the related broom rape [*Orobanche*] which is a common parasite on tobacco and other plants in many parts of the world, and its spread may, therefore, be checked by persistent uprooting and destruction before the seed matures.

The tobacco-growing districts of the Transvaal, owing no doubt to the exceptional rainfall during the month of March of this year, have suffered severely from disease. Wildfire [see this *Review*, ii, p. 37] has been prominent and widespread, and one farmer from Groot Marico reported the ruin of his entire crop of 60,000 plants

from this cause. Angular leaf spot [*Bact. angulatum*] is now also mentioned as occurring in the Transvaal as well as brown spot, mildew, mosaic, and frenching, which all occurred to a greater or less extent.

CLAYTON (E. E.). **The relation of soil moisture to the Fusarium wilt of the Tomato.**—*Amer. Journ. of Botany*, x, 3, pp. 133-146, 3 pl., 1923.

Investigations were conducted at the University of Wisconsin during 1919 and 1920 to ascertain the relation between varying amounts of soil moisture and the development of tomato wilt (*Fusarium lycopersici*). The technique of the experiments and of the methods used in the control of soil moisture is described in considerable detail.

Tomato plants were grown in crocks of sterilized soil inoculated with a spore suspension of *F. lycopersici*. The soil in the crocks was held at moisture contents ranging from 13 to 35 per cent., the latter representing complete saturation, and for the experiments the temperatures were finally raised to the optimum for the disease (about 28° C.). The results of a series of experiments showed that plants growing very rapidly under optimum moisture conditions for vegetative growth are most susceptible to wilt. The plants grown in soil with a low moisture content (13 to 19 per cent.) were very resistant to the disease, a moisture shortage which checked growth bringing about a proportional check in symptoms of the disease. The plants grown in saturated soil were immune from the disease.

Rapidly growing plants in inoculated soil held at a temperature below 20° C. remained healthy, but when they were brought into a temperature favouring the disease (25° to 30° C.), they were soon attacked by wilt, unless the soil was allowed to dry out, in which case the appearance of the disease was retarded. Conversely, plants growing in soil with a low moisture content lost their resistance to the disease if a rapid, succulent growth was induced by the addition of sufficient water to keep the soil moist. Plants growing in the saturated soil also developed the disease as soon as the moisture content was lowered.

With regard to the resistance of plants grown under dry soil conditions, it was found that even when these plants showed no signs of disease they were frequently discoloured in the vascular region and if incubated long enough were killed by wilt. As the fungus produces the disease very slowly, the host is regarded as being resistant under these conditions.

The reason for the relative immunity from wilt of plants grown in saturated soil was also investigated. From microchemical analyses it was found that the nitrogen relations in the saturation plants differed markedly from those of normal ones. Resistance appeared to be correlated with the absence of nitrate nitrogen. To test this theory plants were grown in sand cultures to which nutrient solutions were added. Part of the plants received a complete nutrient solution and the remainder a solution minus nitrate. The tissues of the plants grown in the latter solution were not infected while those which had received the complete nutrient solution developed the disease.

JARDINE (N. K.) **Inspection for plant pests and diseases.**—*Trop. Agric.*, lx, 2, pp. 90–92, 4 pl., 1923.

The Department of Agriculture, Ceylon, has divided its Plant Pests and Diseases Inspection Branch into two divisions, a central one at Peradeniya and a southern one at Avisawella. The work of the divisions is educational, advisory, and official. Special attention is given to the gardens of small native cultivators, who are gradually being educated to realize the importance of pest control as a means to the production of better crops. Advice is given as to the adoption of remedial measures and, if necessary, the regulations for the control of the shot-hole borer of tea and other pests are enforced.

TRAVERSO (G. B.) **L'organizzazione dei Servizi fitopatologici in Italia.** [The organization of the phytopathological services in Italy.]—Reprinted from *Atti XVI Congr. naz. Unione delle Cattedre ambulanti di Agricoltura italiane*, 12 pp., 1923.

A short account is given of the legislation leading up to the present organization of the phytopathological services in Italy, which is based on the Act of 26th June 1913 for the prevention and control of plant diseases, the regulations governing its application passing into law in 1916. The general objects in view are as follows: (1) the study of plant diseases; (2) the control of production and of trade in vegetable products with a view to preventing the introduction of exotic parasites and to circumscribing certain dangerous diseases which are still confined to specified areas; (3) the carrying out officially of control measures; and (4) the organizing and directing of agricultural societies with the object of combating certain plant diseases.

Apart from the administrative section which forms a special department of the general administration of agriculture under the ministry and is aided by a consultant commission (the *Phylloxera* Commission formed in 1879 modified by the Acts of 1911 and 1915), the machinery of the above services consists of: (1) experimental institutes; (2) regional phytopathological observatories or stations; (3) special phytopathological delegates; and (4) plant disease inspectors. On the first devolves the scientific study of diseases and the experimental application of remedies. The observatories have to collect phytopathological material, carry out statistical enquiries and study the behaviour of plant diseases in their own districts. They also issue phytopathological certificates for the dispatch of plants and seeds inland or abroad. The special delegates' duty is to inspect horticultural establishments, nurseries, gardens, markets, &c., to ascertain the health of vegetable products destined for marketing, and to report to their immediate superiors, the directors of the observatories. They have, moreover, to supervise the inspection at the ports and at certain frontier stations of all imported plant material, and function as judicial police in cases of contravention of existing regulations, the reports concerning these being also drawn up by them. The inspectors are in charge of campaigns on a large scale against plant diseases carried out by, or with the aid of, the State but under the immediate direction of the regional observatories. They are also made use of in propaganda work.

The author states, that although theoretically the organization

as outlined is perfect, its working in practice leaves much to be desired. Lack of Government support, financial insecurity, indifference on the part of agriculturists, unsuitable buildings, absence of adequate experiment grounds, and insufficient remuneration of workers, are responsible for the fact that the experimental institutions, namely, the Cryptogamic Laboratory of Pavia, the Station of Agricultural Entomology at Florence, the Station of Plant Pathology at Rome, and the Laboratory of Agricultural Entomology attached to the College of Portici, have failed to maintain their old-established fame as leaders in scientific research on the diseases and pests of plants. These central phytopathological institutions should be placed in a position to undertake serious research and experiment. The technical and scientific personnel for the various services should receive its training there; this is at present obligatory for the inspectors but should be extended to include the special delegates also. The foundation of new experiment stations should not in any way imply that the existing ones are allowed to decay.

Of the twenty-three regional observatories formed in 1917 only about a fourth are independent, the others being branches of various experiment stations, laboratories attached to higher or special schools, or other agricultural institutes, where phytopathological interests are secondary and where this additional and responsible work is undertaken by the local staff without adequate remuneration. The author, while not denying the advantage of the proximity of other experimental or teaching institutes, thinks that the regional observatories ought to have their own properly trained personnel. He is also of opinion that their cost should not fall entirely on the State, as is the case at present, but that the major portion should be borne by the various agricultural and commercial interests concerned.

The special delegates, of whom there are about one hundred, were appointed provisionally from amongst directors and assistants at experiment stations, botanical and research institutes, &c. The composition of the existing staff is regarded as too heterogeneous and the author advocates the appointment of persons who have had more opportunities of getting into touch with farmers and horticulturists. The forestry inspectors and also the staffs of the ambulant agricultural chairs and of anti-*Phylloxera* societies, are thought most suitable. They should not be specialists in either mycology or entomology, but a practical knowledge of the diseases covered by legislation and of the legislation itself, of the most recent research work connected with control measures, and of the manner of taking satisfactory samples for scientific study, is essential, and may be imparted by means of courses to be organized by the Union of Ambulant Agricultural Chairs. The provincial branches of this body might perhaps organize local phytopathological services, but always in co-operation with the regional observatories. Such an arrangement would make for greater uniformity and efficiency.

The plant disease inspectors should be increased in number in proportion to the increase of the regional observatories on which they are dependent. It is also necessary that the State should fix their remuneration at a level to attract young students of promise

in agricultural or natural science subjects, likely to profit by the two years training prescribed by law for these posts.

Under the existing legislation the formation of communal, intercommunal, or provincial organizations for the control of certain plant diseases on the lines of the anti-*Phylloxera* societies, is optional. The author would like to see this made compulsory in certain cases.

From an international standpoint an efficient organization of the phytopathological service is of the greatest importance. It is equally important in the interests of the country itself. Export business depends on it, as is shown by the certificates required in the case of certain important commodities, which are not admitted into other countries without these guarantees. An efficient service may be expected to effect a progressive reduction in the losses caused by the diseases and pests of plants as has been the case in regard to human and animal diseases. The text of a resolution embodying the reforms outlined in the present paper is appended.

A decree to make provision for the protection and preservation of plantations (No. 18 of 1922), Zanzibar, 14th August, 1922.

The Plantations Preservation Decree, 1922, provides for the destruction of clove, lime, orange or other trees or shrubs infected by deleterious fungi of any description, or by the parasites *Loranthus* var. and *Cassytha* var. Similar provision has been made for the destruction of coco-nut trees infested with insect pests. The occupier of land whereon clove or coco-nut trees are grown is required to clean and weed such land at least once every year to the satisfaction of the Director of Agriculture or his representatives. Any inspector may, at his discretion, order the destruction of any tree or heaps of decaying matter attacked by or likely to become a breeding place for any parasite, and, in the event of such order being disregarded by the occupier, may himself take the necessary measures for its execution at the occupier's expense. For the purposes of this decree 'occupier' shall mean the person entitled to the immediate profit of any land, and by a recent amendment (Decree No. 7 of 1923) the term has been further extended to apply also to persons licensed to gather crops and to tenants, irrespective of the period of the licence and of the tenancy.

Amendment No. 2 to regulations governing the importation of Potatoes into the United States (revised).—*U. S. Dept. Agric. Fed. Hort. Board, January* 1923.

As from 1st February 1923, the regulations governing the importation into the United States of potatoes from Canada and Bermuda [see this *Review*, 1, p. 408] have been amended to read as follows:—'Potatoes grown in the Dominion of Canada and Bermuda may be imported into the United States without permit, when accompanied by a certificate issued by a duly authorized officer of the country concerned, indicating the district or locality where grown and apparent freedom from injurious potato diseases and insect pests. Such importations shall be subject to such inspection on arrival as may be required by the United States Department of Agriculture.'